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Leonhard Stejneger

By Albert Kenrick Fisher

THOSE of us who have been privileged by circumstances to have an insight into the various castes of humanity often wonder how soon our beloved country would fade into oblivion if the self-centered, selfish individuals who, to further their own interests, give little thought to veracity, stability, or sincerity, should cease to be in the minority or to be properly controlled by their antitheses.

A pandemia of this kind, which we have a right to fear, probably caused the decadence and downfall of ancient Rome, Greece, Carthage and other almost unknown civilizations. However, when we meet in the various walks of life those who are continually working to uplift humanity and unselfishly to extend our knowledge, we feel reassured and are heartened that the light will be kept burning.

In biology, such a man who worked with untiring energy and zeal in its advancement was Leonhard Stejneger, who passed beyond on February 28, 1943, in his ninety-second year. Born in Bergen, Norway, on October 30, 1851, he came thirty years later to make his home in Washington, D. C., and to continue his zoological research work at the Smithsonian Institution. Professor Spencer F. Baird with his wise discernment had an intuition that Stejneger would be a valuable addition to the scientific corps of the Institution. Although Baird was well satisfied with the fine, detailed natural history work that had been carried on in Alaska by Nelson and others, he deplored the fact that the general regions to the westward, which includes Kamchatka and neighboring groups of islands, had never been similarly explored.

In May, 1882, barely six months after the arrival of Stejneger in Washington, we find him stationed, under the auspices of the Smithsonian Institution and the U. S. Signal Corps, on Bering Island. The plan to have this interesting region faunally explored by one with mature knowledge of the palearctic region clearly shows Baird's keen, innate faculty of making the proper choice to obtain the most favorable results.

Stejneger carried on his explorations in this general region between early May, 1882, to October, 1883, when he left Petropaulowski for San Francisco en route to Washington. In planning for his winter quarters on Bering Island he circumnavigated the island, a trip of over 120 miles, which was made during the latter part of August, 1882. During this trip he spent a couple of days in the locality where Bering had his winter quarters, and there he and a number of his companions died of scurvy in December, 1741. Stejneger's winter stay on Bering Island enabled him to make a study of the birds occurring there at that season, thereby materially adding valuable data, which are set forth in his report, "Results of Ornithological Explorations in the Commander Islands and in Kamtschatka," published in 1885. There are 140 species recorded from Bering Island, and 186 species in the "Synopsis of the Birds Reported to Inhabit Kamtschatka." In both summers of his stay on Bering Island and that of 1883 on Copper Island, he paid

considerable attention to the study of the fur seals and their rookeries as well as the birds.

It is proverbial that a miner on his prospecting trips always has a lingering hope of finding a good gold deposit in some remote ledge and is keenly on the watch for it. Similarly a naturalist is as deeply branded with wishful desires to find some especially rare or vanishing species, more interesting to him than the glitter of gold. Stejneger must have had a deep and alluring hope that in some unfrequented spot he might find a few remaining individuals of Pallas's cormorant, a species virtually exterminated by the Bering party and natives over one hundred years before. On failing to find this hoped-for bonanza, his disappointment may have been aggravated when the natives laughed as he offered them a big reward for a specimen of a species they had not seen since 1850. He got a thrill, however, when he found some cormorant sterna in an extensive bone deposit near the northwest extremity of the island.[1]

On a second trip, in 1895, when he went north to study conditions on the Russian seal islands, he secured a lot of good material from the same deposits. At Cape Tolstoi he found a fragile skeleton of Steller's sea cow (*Rhytina*) and during his stay on the island was able to obtain at least eleven skulls of this wonderful animal. Like Pallas's cormorant, the sea cow was exterminated mainly on account of its value as human food; according to Brandt, this extermination occurred about 1763.

The greater part of the year following his return from the northern trip must have been devoted largely to the production of manuscript covering his reports on the birds of the Commander Islands, and on several orders of birds of the world that he had been chosen to prepare for the bird volume of the "Standard Natural History," published in 1888.

Many of us were disappointed that his absence prevented him from becoming a founder of the American Ornithologists' Union, which had its first meeting in New York in September, 1883. At this meeting Stejneger was elected a fellow, and during the early years of stabilizing the organization he gave important assistance in classification and nomenclature. His earlier studies and association with European ornithologists gave him a good background and an insight into these problems, which in those earlier days were somewhat unsettled and lacked harmony among students.

In 1890 Stejneger developed a bronchial trouble that needed attention and that worried some of his close friends. It was providential that Dr. G. Brown Goode, Assistant Secretary of the Smithsonian Institution, whose every thought was for the welfare of the National Museum corps and for the advancement of the museum collections, arranged to have him go to Arizona. Stejneger had recently been made Curator of Reptiles when Dr. H. C. Yarrow, honorary curator, had resigned. When he reached Arizona, he joined Dr. C. Hart Merriam, who was working on life zones in the San Francisco Mountain region, and so he was materially helped in his collecting work by one having field experience and knowledge of the region. The trip not only restored his health but also gave him an oppor-

1 A more detailed account will be found in COPEIA, (3), Oct. 30, 1931: 76-79.

tunity to study various species of reptiles in life and to make collections of reptiles and other natural history specimens.

With the exception of three months of the sixty years that Stejneger was associated with Washington, I knew him almost from the beginning as a close friend. During this long period, approaching two-thirds of a century, so far as can be remembered, I never saw him in an angry mood, even though at times this would have been considered justifiable.

Some time before the first world war, when conditions were normal, we two planned to make a vagabond trip through parts of Europe, away as much as possible from tourist routes, to get if possible a true understanding of the people. As he understood several languages, the plan seemed especially alluring, and later we often expressed regrets that various circumstances had prevented our going.

His wonderful personality, his kindly, unselfish disposition, his desire to extend a helping hand to those with perplexing problems, and the ease with which he could be approached brought to him a host of friends, admirers, and those truly grateful for his untiring assistance in leading them away from their unsound methods and faulty premises. His popularity was fully demonstrated when a reception and dinner were given him at the Cosmos Club on his 86th birthday. There was a full attendance of friends present to honor him, and quantities of congratulatory letters came from many parts of the world.

Soon after easy transportation was extended to Brookland, a suburb of Washington, Stejneger, Ridgway, and W. B. Barrows built homes on adjoining lots, forming a congenial colony. Doctor Stejneger's place was often frequented by friends who were invited to have a social time, especially when foreign or out-of-town visitors also were guests. These gatherings were informal, everyone was at ease, usually in a happy frame of mind and ready to discuss current political, scientific, and social events. I remember attending a dinner at the Cosmos Club with him where Russians, Danes, Germans, and Norwegians were present; it was a bright occasion full of life and good companionship. After the Stejnegers moved in to Washington in 1915, these affairs were continued, but on account of the war they were often not so carefree. He and his wife never seemed more contented than when they were entertaining friends.

As already stated, Stejneger was born at Bergen, Norway, on October 30, 1851, the son of Peter Stamer and Ingeborg Catharina (Hess) Stejneger. He graduated from the Royal Frederic University of Christiania in 1875, and the same institution honored him with the degree of Doctor of Philosophy in 1930. He married Marie Reiners, of Crefeld, Germany, on March 22, 1892. He and Inga, his adopted daughter, were in close and loving companionship. In 1884, a year after his return from the Commander Islands, he became assistant curator of birds in the National Museum under Robert Ridgway. When Dr. H. C. Yarrow, who, with Dr. S. Weir Mitchell, was interested in toxicology and who carried on numerous experiments to develop a stable antidote to the venom of our poisonous snakes, retired as honorary curator of the department of reptiles in the National Museum in 1889, Stejneger was appointed as his successor. This radical

change in research work from one branch of zoology to another would be a perplexing problem to some investigators, but Stejneger, with his broad basic zoological background as a naturalist, adjusted himself rapidly to the new conditions. He saw in the herpetological field an interesting future work, one into which he entered with zeal and enthusiasm. Through his publications he brought to scientific notice many new forms and interesting facts relating to amphibians and reptiles. We might mention among the Amphibia he described three of unusual interest. These are the "tailed" frog (genus *Ascaphus*) from the state of Washington, the blind cave salamander (*Typhlotriton*) from the Ozarks, and another genus of blind salamander (*Typhlomolge*) from artesian wells near San Marcos, Texas.

To bring better coordination among the departments of biology in the Museum, a head curator position was established, and Stejneger was appointed to it on June 1, 1911. This position, with that of curator of reptiles, terminated only at his death. Under three different assignments he revisited the Commander Islands—in 1895 for the Bureau of Fisheries to study fur seal conditions; in 1896-99 as member of the U. S. Fur Seal Commission; and in 1922 for the Department of Commerce. During the periods between 1901 and 1935 he attended international Zoological Congresses seven times as delegate of the Smithsonian Institution, and the International Ornithological Congress in 1905. He was a member of the International Commission on Zoological Nomenclature from its beginning to his death.

His biological work was fully recognized, and the long list of scientific societies, associations, or clubs in which he held membership shows how widely his influence extended. He was a life member of the Bergen Museum, a member of the National Academy of Sciences, the Washington Academy of Sciences, the Christiania Academy of Sciences, the American Association for the Advancement of Science, fellow of the American Ornithologists' Union, foreign member of the Zoological Society of London, Ornithological Society of Bavaria, member of the Academy of Natural Science of Philadelphia, Biological Society of Washington, Cosmos Club, American Society of Ichthyologists and Herpetologists, honorary member of the California Academy of Sciences, British Ornithologists' Union, American Society of Mammalogists, German Ornithological Society, and Washington Biologists' Field Club. He was Knight, first class, of the Royal Norwegian Order of St. Olaf, 1906, and Commander, 1939. Before leaving Norway he had published two books, "Norsk Ornithologisk Ekskurajonsfauna," 1873, and "Mastozoologisk Ekskursjonsfauna," 1874. After coming to America, one of his first publications was "Results of Ornithological Explorations in the Commander Islands and in Kamtschatka," 1885. He also wrote a large part of Volume IV of the Standard Natural History on Birds. From this time on, almost to the last moment, he prepared many monographs and contributions on zoological subjects, which included the "Herpetology of Porto Rico," 1904, "The Herpetology of Japan and Adjacent Territory," 1907, "The Origin of the So-called Atlantic Animals and Plants of Western Norway," 1907.

His work on "Georg Wilhelm Steller, Pioneer of Alaskan Natural History," published in 1936, is of exceptional worth. With tedious and

painstaking care he brought together from various sources and languages a most interesting and valuable treatise on the life history of Steller, one of the early naturalist explorers of Alaska. One only has to read the volume to have an understanding of the vast amount of delving and patient gleaning in literature that must have been necessary to gather the material from its widely different sources. An added value of the work is the incorporation of considerable that was known of the early natural history of the northern Pacific region.

Another most interesting publication, and perhaps one more generally used than any other of his papers, is the "Check List of North American Amphibians and Reptiles," which, with Dr. Thomas Barbour's assistance, was first issued in 1917 and now has reached its fifth edition. To anyone seriously interested in amphibians and reptiles this book is a necessity. The junior author early in his reptilian studies made contact with Stejneger; the two soon developed a lasting friendship and a mutual understanding.

Dr. Stejneger's mental and physical stability, which endured to the very end, was a marvel. His research work continued without interruption, and he did considerable walking without apparent effort. Even when he attended the field meetings at the camp of the Washington Biologists' Field Club where he had much uphill and downhill walking to do, at the end of the day he was not unduly tired.

The number of scientific men he helped with their problems and worries must be great, for his guidance extended over sixty years. Like the unselfish man who encouraged others to relight their candles from his, he extended brightness over the life of others without dimming that of his own.

U.S. NATIONAL MUSEUM, WASHINGTON, D.C.

Partition of the Genus *Coluber*

By ROBERT F. INGER and PHILIP J. CLARK

IN a previous paper on scale row reduction in snakes, we outlined five subgroups of the genus *Coluber*, i.e., of the genus *Coluber* in the broad sense of recent usage, essentially co-extensive with the *Zamenis* of Boulenger's *Catalogue of Snakes* (Mertens and Müller, 1928: 46; Stejneger and Barbour, 1939: 102–106). These groups were based entirely on reduction patterns. Further study reveals other characters which bear out these subdivisions. If *Masticophis*, as maintained by Ortenburger (1928) and recently by Smith (1941), is to be given generic rank, the partition of the remaining species into generic groups obviously becomes an immediate problem. We believe that the groups established on scale reduction type, with the few supporting characters we are able to discern, may be recognized as genera. The resulting groups are

geographically coherent. Even *Coluber* (as restricted after such a partition), with one of the species in northeastern Asia and the remaining forms in North America, falls somewhat into the familiar zoogeographic pattern of *Elaphe, Agkistrodon, Alligator,* etc. After elimination of the very distinct *Spalerosophis* (Schmidt, 1930), the group, in the broad sense that has been so long current, falls into five restricted generic groups.[1]

I. Coluber Linnaeus

1758 *Coluber* Linnaeus, Syst. Nat., ed. 10, I: 216 (part) (type, *constrictor*).
1853 *Bascanion* Baird and Girard, Cat. N. Amer. Rept., Part I: 93.
1853 *Masticophis* Baird and Girard, Cat. N. Amer. Rept., Part I: 98 (part).
1854 *Coryphodon* Duméril and Bibron, Erp. Gén., 7: 180 (part).

Diagnosis.—The scale reduction pattern is characterized by absence of vertebral reductions, by non-increase in the number of dorsal scale rows behind the neck, and by non-alternation of reductions between low and high levels. A typical formula for this genus is that of *Coluber constrictor constrictor:*

$$\text{FMNH}\quad 34740\quad 19\ \left(\frac{\frac{8}{(3+4)}}{\frac{(3+4)}{7}}\right)\ 17\ \left(\frac{\frac{101}{(3+4)}}{\frac{(3+4)}{103}}\right)\ 15\ \frac{169}{169}$$

When seven supralabials are present, the third and fourth enter the orbit; when eight are present, the fourth and fifth enter the orbit. The posterior pair of chin shields is separated by small scales for their entire length. Hemipenis usually with enlarged basal spines.

Coluber constrictor constrictor Linnaeus
Coluber constrictor flaviventris Say
Coluber constrictor mormon Baird and Girard
Coluber constrictor priapus Dunn
Coluber constrictor stejnegerianus Cope
Coluber spinalis Peters

Range.—Northern China, Mongolia, Korea; United States, southern British Columbia, northern Mexico.

II. Masticophis Baird and Girard

1758 *Coluber* Linnaeus, Syst. Nat., ed. 10, I: 216 (part).
1853 *Masticophis* Baird and Girard, Cat. N. Amer. Rept., Part 1: 98 (part) (type, *ornatus*).
1854 *Coryphodon* Duméril and Bibron, Erp. Gén., 7: 180 (part).

Diagnosis.—Dorsal scale formula characterized by vertebral reductions, by non-increase in number of rows posterior to the neck, and by non-alternation of reductions between low and high levels. A typical reduction formula is that of *Masticophis flagellum flagellum:*

$$\text{FMNH 23399}\quad 21\ \left(\frac{\frac{7}{(4+5)}}{\frac{(3+4)}{7}}\right)\ 19\ \left(\frac{\frac{11}{(3+4)}}{\frac{(3+4)}{11}}\right)\ 17\ \left(\frac{\frac{121}{(3+4)}}{\frac{(3+4)}{120}}\right)\ 15\ \left(\frac{8}{\frac{\quad}{+7}}\right)\ 14\ \left(\frac{\frac{158}{7+7}}{158}\right)\ 13\ \left(\frac{7}{\frac{\quad}{+6}}\right)\ 12\ \frac{194}{194}$$

Fourth and fifth supralabials enter orbit; posterior pair of chin shields usually

[1] Throughout the course of this study we have been much aided by Messrs. Karl P. Schmidt and Clifford H. Pope, to whom we are grateful for advice and for permission to use the laboratories and collections of the Field Museum of Natural History.

separated posteriorly by several small scales. Hemipenis with enlarged basal spines.

The following forms belong in this genus:

Masticophis anthonyi Stejneger
Masticophis aurigulus Cope
Masticophis barbouri Van Denburgh and Slevin
Masticophis bilineatus Jan
Masticophis flagellum flagellum Shaw
Masticophis flagellum flavigularis Hallowell
Masticophis flagellum lineatulus Smith
Masticophis flagellum piceus Cope
Masticophis lateralis Hallowell
Masticophis mentovarius Duméril and Bibron
Masticophis ortenburgeri Stuart
Masticophis taeniatus australis Smith
Masticophis taeniatus girardi Stejneger and Barbour
Masticophis taeniatus ruthveni Ortenburger
Masticophis taeniatus schotti Baird and Girard
Masticophis taeniatus striolatus Mertens
Masticophis taeniatus taeniatus Hallowell

RANGE.—Western North America south of 45° North; eastern North America south of 38° North: south to Guatemala.

III. ZAMENIS Wagler

1830 *Zamenis* Wagler, Nat. Syst. Amph.: 188 (part) (type, *gemonensis*).

DIAGNOSIS.—Dorsal scale formula characterized by increase of number of rows behind the neck, by lack of vertebral reductions, and by non-alternation of reductions between low and high levels. The following scale formula of *Zamenis jugularis* is typical of the genus.

$$\text{FMNH 19619}\quad 21\ \left(\frac{\overset{6}{3+4}}{\underset{7}{4+5}}\right)\ 19\ \left(\frac{\overset{10}{3+4}}{\underset{10}{3+4}}\right)\ 17\ \left(\frac{\overset{44}{3=3+4}}{\underset{44}{3=3+4}}\right)\ 19\ \left(\frac{\overset{118}{4}}{\underset{117}{5}}\right)\ 17\ \left(\frac{\overset{135}{2+3}}{\underset{136}{2+3}}\right)\ 15$$

Fourth and fifth supralabials entering orbit. Chin shields not separated by small scales. Hemipenis without enlarged basal spines.

The species and subspecies of this genus are listed below:

Zamenis dahlii Fitzinger
Zamenis gemonensis Laurenti
Zamenis jugularis asianus Boettger
Zamenis jugularis caspius Gmelin
Zamenis jugularis jugularis Linnaeus
Zamenis viridiflavus carbonarius Bonaparte
Zamenis viridiflavus viridiflavus Lacépède

RANGE.—Southern Europe, North Africa, and western Asia.

IV. PLATYCEPS Blyth

1860 *Platyceps* Blyth, J. As. Soc. Beng., xxix: 114 (type, *Coluber ventromaculatus* Gray, 1834).

DIAGNOSIS.—Dorsal scale reduction pattern characterized by alternation of reductions between low and high levels, by non-increase of number of scale rows posterior to the neck, and by lack of vertebral reductions. The scale formula of the type species, *ventromaculatus*, is given below:

$$\text{FMNH 19501}\quad 21\ \left(\frac{\overset{11}{3+4}}{\underset{10}{3+4}}\right)\ 19\ \left(\frac{\overset{134}{8+9}}{\underset{134}{8+9}}\right)\ 17\ \left(\frac{\overset{135}{3+4}}{\underset{134}{3+4}}\right)\ 15\ \left(\frac{\overset{171}{6+7}}{\underset{172}{6+7}}\right)\ 13\ \overset{215}{\underset{215}{\ }}$$

Fifth and sixth supralabials enter orbit. Posterior pair of chin shields separated along entire length by small scales. Hemipenis without enlarged basal spines.

The genus is composed of the following species:

Platyceps florulentus Geoffroy St. Hilaire
Platyceps najadum Eichwald
Platyceps ravergieri Ménétriés
Platyceps rhodorachis Jan
Platyceps rogersi Anderson
Platyceps ventromaculatus Gray

RANGE.—Southeastern Europe and southwestern Asia.

V. HAEMORRHOIS Boie

1758 *Coluber* Linnaeus, Syst. Nat., ed. 10, I: 216 (part).
1826 *Haemorrhois* Boie, Isis: 982 (type, *hippocrepis*).
1830 *Periops* Wagler, Nat. Syst. Amph.: 189.

DIAGNOSIS.—Scale formula characterized by increase in number of rows posterior to neck, by alternation of reductions between low and high levels, and by lack of vertebral reductions. The formula of *Haemorrhois hippocrepis* follows:

$$\text{FMNH 15747}\quad 25\left(\frac{4+5}{4+5}\right)^{\frac{18}{18}}23\left(\frac{11=11+12}{10=10+11}\right)^{\frac{46}{47}}25\left(\frac{10+11}{10+11}\right)^{\frac{127}{124}}23\left(\frac{4}{4}\right)^{\frac{131}{130}}21\left(\frac{9+10}{9+10}\right)^{\frac{144}{146}}19\left(\frac{8}{8}\right)^{\frac{176}{176}}\ 232$$

Subocular plates present; no supralabials in contact with orbit. Both pairs of chin shields separated by small scales. Hemipenis without enlarged basal spines.

This genus is monotypic, with only: *Haemorrhois hippocrepis* Linnaeus.

RANGE.—Spain, northwestern Africa, Sardinia, and certain small Mediterranean islands.

Scale reduction patterns are unknown for *Coluber fasciolatus* Shaw, *Coluber karelinii* Brandt, *Herpetodryas dipsas* Schlegel, *Periops algirus* Jan, *Periops dorri* Lataste, and *Zamenis socotrae* Günther, specimens of which have not been available. Allocation of these species must wait until their scale formulae are determined.

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Terrarium Notes on Californian Reptiles

By GEORGE H. HANLEY

EATING OF MICE BY WESTERN GLOSSY SNAKES

ON two occasions I have had rather large specimens of *Arizona elegans occidentalis* Blanchard take house mice. The snakes were caught near Bakersfield, California. Each time, the mice were struck at while they walked across a vertical screen cage-side; the snake struck from behind a pile of shavings, seizing the mouse squarely on the head and neck on the first attempt, with immediate constriction, in which the coils were closer together and more numerous than is usual with *Pituophis c. catenifer*. In all other cases I had fed *A. elegans* nothing but lizards; Perkins (1938, Bull. Zool. Soc. San Diego, 13: 35) reports this species as feeding on lizards and not on mice. On May 11, 1941, I found a DOR specimen of this species containing a recently eaten mouse.

One out of about a dozen specimens I have observed was exceptional in biting several times at hands entering its cage. There was no preliminary hissing, though a single hiss accompanied each strike.

NOTES ON *Diadophis amabilis* SUBSPP.

A ring-necked snake kept as a pet for about a year lived on small hylas, slender salamanders, and small larvae of toads and hylas. It invariably refused small fishes, earthworms, insects, and small utas. Insects were not offered often enough or in great enough variety to form a conclusive experiment.

On one occasion a very small toad was grabbed and quickly released. This was followed by contortions of the foreparts of the body, opening and distending of the jaws, and rubbing of the head on objects in the terrarium. Toads were refused thereafter though toad larvae were taken both before and afterwards.

This snake seemed to prefer slender salamanders to any other food, taking them more readily and showing considerable dexterity in working the head or tail end into position by "walking" the jaws sideways. At one feeding five were consumed. Eight small hylas were eaten at one feeding, and more were refused. Twelve moderately sized toad larvae were accepted at another feeding.

Even in a limited space, such as a gallon jar, the tree toads were too active for the snake to catch. Hylas were best fed to the snake by holding them by their hind legs with the fingers. Amphibian larvae were never accepted in water. They were taken only from the hand or when removed from water and placed in a moist jar lid. They did not need to be alive.

The ring-necked snake showed no evidence of using its eyes in stalking, but seemed to use its tongue exclusively. It would often try to bite objects touched by salamanders or hylas, even the glass walls of the container. On several occasions, when a salamander had crawled around the terrarium and come to rest in plain sight close to the head of the snake, the snake followed the whole path of the salamander with his tongue before attempting to catch it. Once the first strike was made, successive strikes seemed to depend on sight; accuracy of striking was very poor.

I am inclined to believe slender salamanders are the main food item of *Diadophis* in California. Mr. Perkins of San Diego states that he shares this belief. I have kept three additional adult specimens of ring-necked snakes (perhaps not all of the same subspecies), which also fed by preference on salamanders.

A specimen caught in the Berkeley Hills is identifiable as *Diadophis amabilis amabilis*. It laid two yellowish eggs on July 2, 1937. One of these eggs (preserved in formalin) measures 32 mm. by 7½ mm. Osmosis may have increased its size. The parent snake measures 340 mm. in length.

Feeding Habits of *Anniella pulchra pulchra* Fischer

A legless lizard was caught in the coastal dunes near Los Angeles during July and kept in a small jar of sand for about a month. For the most part it was fed termites and well "trimmed" house flies. Ants and wood lice (*Oniscus*) were refused. This specimen would not take food while it was above the sand but first would crawl under the surface to come up directly under the morsel. It seemed to be able to locate termites dropped on the sand by some sense, invariably rising at exactly the right spot to grab the insect.

Notes on *Rhinocheilus lecontei lecontei* Baird and Girard

Rhinocheilus is rather common near Bakersfield. Little is known of its habits. The largest individual I have caught excreted a considerable amount of musk and blood onto my glove. The strong smelling musk penetrated my glove to such a degree that it was strongly scented for two years. The

snake, though picked up on the highway, showed no signs of injury. It was kept in a terrarium for about two months. I have not observed the excretion of blood in four other *Rhinocheilus* caught.

This species feeds readily in captivity, usually accepting utas from the fingers. Other food has always been refused, even other lizards, such as small fence lizards (*Sceloporus*).

Individual Differences in *Pituophis catenifer catenifer* Blainville

Extreme individuality in disposition and habits of the gopher snake make it an interesting snake for the terrarium. It is the most common snake in the Bakersfield region. In the spring and fall of 1941, out of 49 snakes seen (including DORs), 26 were *P. catenifer catenifer*. These were mostly observed within 20 miles of the city on evening drives. The other 23 represented the following forms: *Crotalus viridis oreganus*, 6; *Coluber flagellum frenatus*, 5; *Arizona elegans occidentalis*, 4; *Lampropeltis getulus californiae*, 4; *Rhinocheilus lecontei*, 3; *Hypsiglena ochrorhyncha*, 1.

Two Pacific gopher snakes picked up during the same week (in 1939) as they crossed the highway at dusk, within a hundred yards of the same spot, exhibited the extremes of individual behavior. They were of about the same length (about 30 inches), but one was more stocky in body than the other.

The heavier specimen, when picked up, coiled around my wrist with all the docility of a rubber snake, with no sign of hissing or biting. The other hissed and struck. Even when held, it turned about and chewed on my hand. This unpleasant habit was retained during the month the snake was a captive.

The slender specimen refused all warm-blooded food, eating only lizards of the genus *Uta*, and refusing to eat at all under observation. Hissing and blowing were continuous in the presence of any observer. The more lethargic specimen refused lizards but accepted house mice readily, taking one directly from my fingers. It ate a fledgling English sparrow on an open table top surrounded by a small audience.

Note on *Charina bottae* Blainville

A rubber boa picked up on the road about midnight near Sequoia National Park was kept in the terrarium for over a year and a half. During the time it was kept as a captive it ate nothing of its own free will. Partial force feeding was necessary. At first eggs and hamburger were fed with a rubber syringe. Later I happened onto a better method. If the end of a long strip of beef was forced into the boa's mouth, it would continue swallowing providing the end was tugged. If the pull was released the meat was quickly regurgitated. An irregular but gentle pulling at the end of the strip with the fingers had the best effect.

This snake later became infested heavily with mites contracted from a tropical American boa. It was much more affected than was the original host. Other harmless snakes in the same pen were only slightly infested.

Bakersfield, California.

Rediscovery of the Philippine Discoglossid Frog, *Barbourula busuangensis*

By George S. Myers

NEXT to the Ascaphidae,[1] the frogs of the family Discoglossidae, which also retain ribs, are probably the most primitive of living Salientia. The family is a small one and for many years but three genera were known. *Discoglossus* (one species) and *Alytes* (two species) inhabit Europe and the Mediterranean region, while *Bombina,* with two species in Europe and two in China, Korea and Indo-China, is more widely distributed. It was, therefore, an herpetological event of first magnitude when, in 1924, Taylor and Noble (1924: 1) announced the discovery of a new genus and species of discoglossid on Busuanga Island, in the Calamianes group north of Palawan. Taylor and Noble showed that *Barbourula* was a very distinct genus, probably most nearly allied to *Bombina.* The type and only specimen (now in the Museum of Comparative Zoology) was the only example of its species obtained by Dr. Taylor in 1923 during the second of two rather extensive herpetological surveys of Busuanga, and it has remained unique. Taylor and Noble even speculate upon the apparent rarity of the frog, and suggest that it may be nearing extinction.

In 1940, when my friend and colleague, Dr. Albert W. Herre, of Stanford University, began preparations for another Asiatic expedition, I asked him to obtain whatever herpetological materials he could, and especially requested that he make a special trip to Busuanga to search for *Barbourula,* for which journey extra funds were provided by the Stanford Natural History Museum. When Dr. Herre wrote me, after his sojourn on Busuanga, that he had gotten every frog of every sort in sight, I waited for his Busuanga shipment with great expectation, and upon its arrival I was overjoyed to unwrap specimen after specimen of *Barbourula* until a series of twenty-three was safely stowed away in our museum jars.

The specimens are beautifully preserved, having been killed and fixed in 3 or 4 per cent formalin. They show that Taylor and Noble were correct in diagnosing their type as an immature example. The species is a large one, exceeding the largest ranid frogs collected by Dr. Herre on Busuanga, and is by far the largest of the Discoglossidae. The largest adult (no. 6004) measures 88 mm. from snout-tip to vent, and 190 mm. with legs outstretched. Two others are nearly as large. In appearance, our specimens closely resemble Taylor and Noble's illustration of the type. The legs have the joints and tarsus rather thickened and the tibia little tapered, resembling the legs of *Ascaphus, Bombina,* and *Ooeidozyga,* and also somewhat those of *Liopelma. Barbourula* is a robust, heavy bodied frog, with a bluntly rounded snout and no obvious distinguishing marks save its apparent lack of special structures and its somewhat peculiar contours. As Taylor and Noble remark, the species remarkably resembles the aquatic ranid, *Ooeidozyga laevis,* and Dr. Herre's larger examples of *O. laevis* from other islands continually deceived me when

[1] Liopelmidae of Noble. With most other zoologists, I hold that the valid name of a family is that name with an -idae (or perhaps even an -inae) ending first used for the group or a component part of it, and based upon a valid genus of the group.

I was unpacking them. One external feature will unfailingly distinguish between the two species. Just below the eye, *Barbourula* possesses a peculiar, short, dermal process, like a tiny tentacle or barbel, which projects laterally. This structure is shown on the right side in the illustration of the type, but is not mentioned by Taylor and Noble. *Ooeidozyga* has no such structure. Laterally viewed, *Barbourula* is seen to be somewhat though not greatly flattened, as in many thoroughly aquatic frogs. The dorsum is closely covered with tiny, rather equal warts, and the toes are fully webbed.

It is probable that Taylor's type was obtained in the lowlands, as it was taken with numerous *Ooeidozyga laevis*, a lowland species that does not appear in Dr. Herre's upland brook collections, in which the majority of his *Barbourula* occur. The interior of Busuanga is composed of low, rolling hills, largely deforested, and the trees present are mostly along the upper parts of the watercourses.

Dr. Herre's *Barbourula* were, with a single exception, labelled "Suñgai" or "Siñgai" (the native—and Malayan—name for brook or creek) and he locates this brook as follows: The town of Coron is located on the eastern end of the southern coast of Busuanga. From the town a road leading westward roughly parallels the coast. A few miles out of town on this road, at a point where it has left the sea to avoid coastal swamps, one comes to its junction with a road leading inland. The inland road trends northward and then northeastward, crossing the lowland Wayan Creek, which flows southward into mangrove swamps. Beyond Wayan Creek the road arrives at the small *barrio* of San Nicolas and, 3 or 4 miles beyond San Nicholas, at a manganese mine. This mine is in the lower hills, at an altitude of 500 or 600 feet. Dr. Herre made his headquarters at the mine camp, and most of his Busuanga frogs (save those from Wayan Creek and Coron) came from within an hour's walking distance of the mine. The "Suñgai" of Dr. Herre's labels is the brook that supplies water for the mine camp. It is a tributary of a stream flowing northward. Just above the mine the "Suñgai" is dammed to form a reservoir pool. Above the dam and pool, the stream is a small hill brook, and it is in this part of the brook that twenty-two of the twenty-three *Barbourula* were collected. The brook in this section is only 3 to 10 feet wide, with the usual rocky bed and occasional riffles and a few pools not over a yard deep. It is shaded to a greater or lesser degree—sometimes deeply shaded—by second-growth timber or perhaps occasionally by a little virgin forest. The brook is inhabited by *Rasbora* and *Nematabramis*. *Rana acanthi* and *Staurois natator* were common, the former frequently seated upon boulders in or along the stream, from which they took enormous leaps into the water. Specimens of *Barbourula* were seen now and then in the water, with only the nostrils and eyes above the surface, and they immediately sank or swam off to the bottom or hid under stones when disturbed. As Taylor and Noble suspected, the species seems to be entirely aquatic, but its true habitat is in hill brooks rather than in the lowlands.

Dr. Herre also collected at Wayan Creek near the road, where there is comparatively little current and the stream is deep, sluggish, and weed-grown. Here he got only one half-grown *Barbourula* (no. 6043) together with numerous *Ooeidozyga laevis*, exactly as Taylor did when he collected the type.

The Suñgai frogs (Stanford Amphib. Cat. nos. 6004–6024, 6037) were collected on June 19 and 21, 1940. The Wayan Creek individual (no. 6043) was collected on June 21, 1940.

It is not likely that *Barbourula* will be found on Culion Island, between Busuanga and Palawan, since Culion is much drier, lacking both the heavy rains and the permanent streams of Busuanga. But *Barbourula* should certainly be looked for in the largely unexplored and unmapped interior of Palawan, of which the Calamianes Islands are merely a northward extension. Without showing much faunal relationship to the more northerly Philippines, Palawan and the Calamianes are faunally very similar to each other and to British North Borneo. In the latter region, zoological exploration seems to have been confined almost exclusively to the towering heights of Mt. Kinabalu, in spite of the fact that the North Borneo lowland fauna is rather different from that of Sarawak and Dutch Borneo. I should not be at all surprised to see *Barbourula* turn up in Palawan or even in North Borneo. It very likely occurs in the practically inaccessible interior of Coron Island, opposite the town of Coron on Busuanga, but if it does it is not likely to be collected soon on that forbidding limestone mass.

Superficial examination seems to confirm Taylor and Noble's suggestion that the closest known relative of *Barbourula* is *Bombina* of the Eurasian mainland. *Barbourula* shows no sign of the gay belly marbling of *Bombina* (bright red in *B. bombina* and *B. orientalis,* bright yellow in *B. variegata* and *B. maxima*), and it is very different in many other ways. Its geographical situation alone shows that *Barbourula* must have been widely separated from its relatives on the Asiatic mainland for a long time. Geographically, *Bombina maxima* (of Yunnan and the highlands of Tonkin) is the closest species, but whatever migration route was followed by *Barbourula* was much longer than its present air-line distance from Tonkin. The Calamianes and Palawan have had, in my opinion, no direct dry land connection with the other Philippine islands to the north and east, or with Indo-China. They are related zoogeographically only to Borneo, of which they form a northward continental extension, and they have been cut off from Borneo by the sea only in relatively recent geological times. The ancestors of *Barbourula* must have arrived via the main Malay Archipelago at a time when Sundaland was upraised, and the present absence of Discoglossidae in Borneo and the Sunda chain, as well as in the Malay Peninsula, Siam, and most of Indo-China, indicates that *Barbourula* is an exceedingly isolated relict.

It is intended to pursue anatomical work on our specimens as soon as time is available. Two of the frogs are now in Field Museum, which helped to underwrite Dr. Herre's trip, and another is in the Museum of Zoology of the University of Michigan.

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A New Ambystomid Salamander Adapted to Brackish Water

By Edward H. Taylor

THE presence of common salt in water, in any considerable quantity, renders it unfit for the development of the eggs and larvae of amphibians. Marine waters have consequently proved a strong barrier to the distribution of this group of animals. A very few amphibians have eggs and larvae capable of development in waters having some quantity of sodium chloride in solution, while many species appear to develop in alkaline waters of varying concentration.

A. S. Pearse (1911) found tadpoles in water in crab holes which were covered daily by the tide water from Manila Bay. In consequence the water had a fairly strong salt concentration. Pearse does not mention the species, but I presume it to be *Rana moodiei* Taylor, since I have found its tadpoles near Manila, in brackish water in crab holes, though above the tide-mark. On one occasion I captured an adult on the edge of the beach, from under a piece of coral, where it sat partially submerged. One might suspect that certain species with a wide archipelagic distribution might be more tolerant of sodium chloride concentrations than continental forms.

The presence of larval newts in brackish water was recently reported in England (Spurway, 1943, and Hardy, 1943). Weismann (1878) was under the impression that the habitat of *Siredon mexicana* is brackish water. I believe that this is an error, since both Lake Xochomilco and Chalco are fresh water lakes (Chalco is now almost entirely drained and cultivated). It is true that there are bodies of brackish water in the Valle de México but *Siredon mexicana* is not to be found in them. I do not believe any of these bodies of brackish water have other ambystomids.

The discovery by Mr. Dyfrig McHattie Forbes of a salamander living in the saline waters of Lake Alchichica, Puebla, México, is thus of especial interest and importance. It proves to be a species differing from other known forms, and is described below.

Laguna Alchichica is one of a series of three small lakes in the high plateau region lying to the northwest of the great volcano Citlaltepetl (Orizaba). The region about them is flat and all seem to have been formed by a sinking of the surface crust. They do not seem to be crater lakes. The lakes differ in level, in the salt content of their waters, and in their fauna and flora. The actual depth of the water is not known in any of them.

Laguna Quecholac and Laguna de la Mina Preciosa contain potable fresh water. They support a heavy growth of rushes about their edges, with many algae in the water. Each lake has, at least, one species of fish, and one salamander. Laguna Alchichica, with water distinctly salty to the taste, has no fresh water rushes or algae, and only submerged seaweed-like plants were observed, growing on rocks. There is a single species of fish,[1] and the salamander here described.

[1] Announced by De Buen, at the 1942 Annual Meeting of the American Society of Ichthyologists and Herpetologists, as a new species of *Chirostoma*.

The fishes from Quecholac and Laguna de la Mina Preciosa presumably belong to the genus *Chirostoma*. Both fishes and salamanders differ from the species in Lake Alchichica.

Dr. Hobart Smith and I visited Lake Alchichica in 1932, but because of the salinity of the water we made no effort to collect salamanders, presuming that they could not occur. In 1939 Mr. Dyfrig McH. Forbes, unaware that salt water is usually not tolerated by amphibians, investigated the lake and succeeded in obtaining two ambystomid larvae. On the same visit a specimen of a transformed adult was found a few hundred yards from the lake. This specimen is the type of the new species. I returned to the lake in 1940, and with my son, Richard Taylor, succeeded in obtaining two dead larvae that had been washed on shore. In 1941, with Mr. Forbes, Mr. Gabino Garcia, and party, I succeeded in obtaining a good series of larvae in the quiet waters near the shore, late at night. The animals, at this time, appear to come from the deeper water to feed near the edge. A sample of water brought from Lake Alchichica was analyzed by Mr. E. O. Holmes[2] of the Water and Sewage Laboratory of Kansas University. The analysis is given below.

ANALYSIS OF LAKE ALCHICHICA WATER SAMPLE

	p.p.m.		p.p.m.
Iron (Fe)	0.79	Fluoride (F)	0.0
Calcium (Ca)	9.6	Total Solids	8,283
Magnesium (Mg)	349	Total Hardness (calculated as $CaCO_3$)	1,459
Sodium and Potassium (Na and K)	2,570	Carbonate Hardness (do)	1,459
Bicarbonate (HCO_3)	1,068	Non-carbonate Hardness (do)	0
Carbonate (CO_3)	624	Total Akalinity	1,915
Sulfate (SO_4)	970	Excess Alkalinity ($NaHCO_3$)	456
Chloride (C1)	2,595	Insoluable residue (including SiO_2)	17
Nitrate (NO_3)	1.1		

Ambystoma subsalsum, sp. nov.

Figs. 1–3

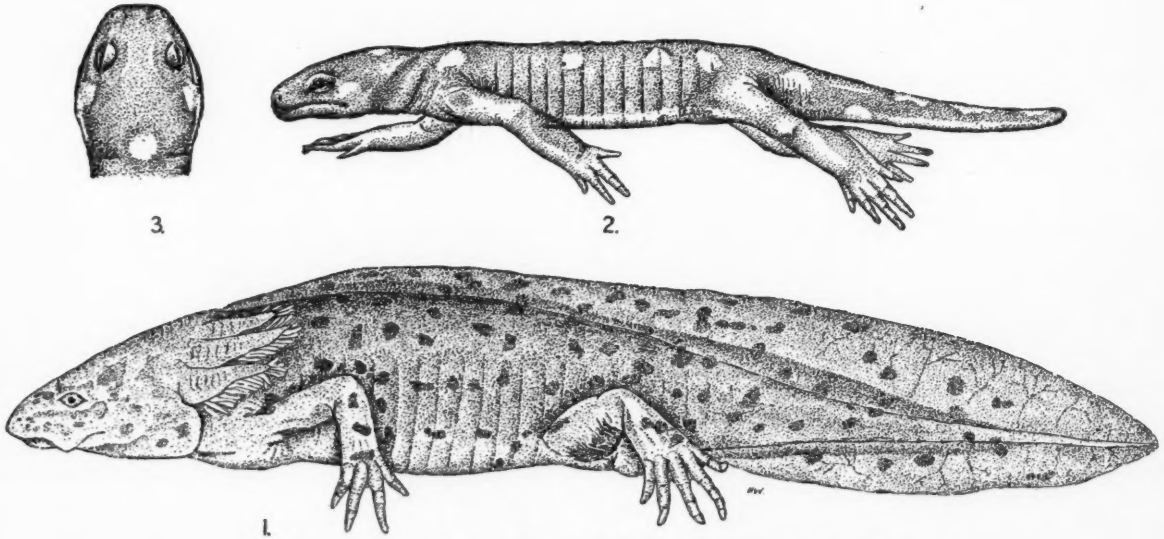
TYPE.—E. H. Taylor—H. M. Smith, No. 22139, transformed, young adult ♀. Collected at Lake Alchichica, Puebla, 1940, by Dyfrig McH. Forbes.

PARATYPES.—E. H. T.—H. M. S., Nos. 24013—24014; 28357—28390; U. S. National Museum, No. 12989, all larvae, taken in Lake Alchichica by Dyfrig McH. Forbes and Edward H. Taylor.

DIAGNOSIS.—A medium-sized ambystomid salamander; tail short (about 61% of body), narrow, its width contained in its length less than 5½ times. Tongue spongelike with longitudinal lamellae; vomero-pterygoid teeth 27–26; maxillary-premaxillary series 54–58, with a similar number of mandibular teeth. Phalangeal formula: 2,2,3,2,; 2,2,3,4,2. Dark lead color with cream spots, paired on body, single on tail; a pair of spots behind eyes, and a single medial occipital spot; venter clouded.

DESCRIPTION OF TYPE.—The type is a transformed immature female. Head a little wider than long; interorbital width about one sixth greater

[2] I wish to acknowledge my indebtedness to Mr. Holmes for the water analysis and to Mr. S. W. Lohman for helpful advice and information in preparing this table.



1. *Ambystoma subsalsum,* sp. nov.; larva; U.S. National Museum No. 116702; about natural size.

2. *Ambystoma subsalsum,* type, EHT-HMS No. 22139; Laguna Alchichica, Puebla, Mexico; about natural size.

3. Same; dorsal surface of head.

than the length of the snout; length of eye a little less than distance between eye and nostril; nostril, narrow, slit-like, opening upward and backward; region about nostrils swollen, with a broad, flat depression between; interorbital region, nearest orbits, somewhat depressed.

Choanae large, the vomero-pterygoid tooth series interrupted by a diastema, between the vomerine and pterygoid parts, equal to space between three teeth; the vomerine parts are apparently continuous without a diastema medially; the somewhat angular arch formed by the combined series beginning behind, but near outer level of choanae, and medially reaching the anterior level of choanae.

Tongue broader than long, with a median longitudinal groove; longitudinal lamellae very spongy in character, due to numerous calyculate openings between and on the lamellae; lateral edges of tongue free.

Arms and legs long; the toes reaching a little beyond elbow when addressed to body; digits short, bluntly pointed, with more or less horny deposit at tips; order of length of the fingers 1, 4, 2, 3; no trace of web; a pair of moderately distinct palmar tubercles; sides of the toes with slight skinfolds, most evident on the outer side of first and fifth toes; a pair of tubercles on sole.

Skin smooth on the dorsal surfaces save for minute pits and corrugations (visible under the lens); no evidence of large glandular pits, or other trace of the larval neuromast system. The number of costal grooves distinguishable only with difficulty (due to injury), apparently 10 or 11; 25 vertebrae in tail behind anus.

Color.—Above, dull blackish-gray or lead color; head with a small occipital cream spot and a similar spot back of angle of jaw more or less continuous with the dirty cream color of the upper and lower lips; four irregularly paired cream spots on body; one pair on the shoulders, two on the back, and one on the rump; a spot at base of tail on each side, and a single dorsal spot; three larger, elongate, cream colored spots on dorsal part of the sharply compressed tail; anterior face of arms and legs each with one or two elongate diffuse light spots or areas; toes largely cream color; ventral surfaces dirty cream with deeper clouding on posterior abdomen.

Measurements (in mm.).—Snout to posterior end of vent, 77; posterior end of vent to end of tail, 47; width of head, 18; length of head, 18; arm, 30; leg, 27.5.

Description of Larva.—E. H. T.—H. M. S. No. 28369. Snout to vent 86 mm; head slender, the greatest width equal to distance between tip of snout and the neck fold (median measurement), and the distance from the tip of the snout to the (dorsal) base of gills two-fifths greater than the width; snout truncate, nostrils terminal, pointing forward; interorbital width equal to distance between posterior corner of eye and snout tip; distance between nostrils equal to distance between eye and nostril; head with paired series of pits (neuromast organs) extending from near tip of snout to occiput; a row extending downward and forward from the posterior end of this line passing below the eye; two irregular, nearly parallel rows run diagonally down and back from eye, the anterior across the angle of the jaw.

The upper series of 13 (14) neuromast organs are evident. They begin on the dorsal surface, somewhat back of the base of the gills, and continue to a point beyond the middle of the tail; there is one break in the series on the middle of the back, on the right side, and two on the left. The median series are faintly evident on the sides, extending to the base of the tail; the indistinct ventrolateral series are about on the level of the arm insertion. All the organs appear as black spots.

Dorsal fin arising medially on a level with the base of the upper gill; and continuing to the tip of tail, its greatest elevation about the middle of tail; muscular part of tail very narrow, attenuated; ventral narrower than dorsal fin.

The digits of the larvae differ from those of the transformed individual in being a little wider at the base, more flattened, and in having the edges of all with a "skinfold or fringe." The tissue between the metacarpals and metatarsals "weblike." Costal grooves, indistinct in axilla and groin, number 10 or 11 (13 counting an axillary and inguinal). Leg proportionally longer than in the transformed animal, reaching almost to the axilla. There is no horny deposit at the tips of the toes. Formula for gill rakers: 1st, single, 12; 2nd, double, 12–12; 3rd, double, 12–10; 4th, single, 10. Maxillary-premaxillary tooth series 37–38; mandibular series 35–36; splenial teeth 33–40, in elongate series, single or double, extending ⅔ the length of the mandibular series; vomero-pterygoid series 10:25; 25:10.

In life the specimens are bright golden to canary yellow, with numerous punctate black spots.

VARIATION.—In the older or larger specimens the lateral line organs are often indistinct or wanting. The tails of males are usually a few millimeters longer than those of females, and the cloacal region is more swollen. Measurements of a series of larger males and females show only small differences in relative body proportions. The largest male larva measures (in mm.) length 176, tail 82, width of head 26, head length to neck fold 23, axilla to groin 41, arm 31, leg 33. The largest female measures length 199, tail 87, width of head 30, head to neck fold 24, axilla to groin 55, arm 40, leg 41.

REMARKS.—Most of the larvae appear to be neotenes. Females 65 mm. in length from snout to vent, have the cloacal region inflated as much as the larger females (90–94 mm.) and the ovarian eggs are at about the same degree of development. The eggs are rather small, but many are already pigmented, suggesting that they are approaching maturity. Males of the same size appear sexually mature with large, elongate, cream-colored testes attached to very large fat-bodies. The lips of the cloaca are much inflated with small, rather indistinct papillae, which are lacking in the females. This lot was collected August 14 and 15, 1941.

The largest specimen, a female, together with another female nearly as large, was found dead, having washed ashore July 24, 1940, during a strong (fair weather) wind. They had apparently spawned, as their ovaries contain only minute eggs, and the cloacal regions are not greatly inflated.

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The Breeding Habits of Sea Snakes

By A. M. BERGMAN

IN a paper by the late Dr. Kopstein (1938) on the eggs of the reptiles of Java, the only note with regard to the sea snakes is that two female *Thalassophis*, caught in November, 1928, at Cheribon, contained respectively two and four embryos. In her catalogue of reptiles, de Rooy (1916) gives no information other than the statement that these snakes are viviparous, and in the best monograph available for the group, Malcolm Smith (1926) makes the following statement: "Breeding appears to take place at certain seasons of the year only, but information upon this point is scanty. In the gulf of Siam the majority of the species produce their young during March and April."

Since 1936 we have collected sea snakes at Sourabaya, Java, which have been weighed, fixed in Bouin's liquid (Bergman, 1938), and opened ventrally. Measurements have been taken of the internal organs of these specimens.

This material has become sufficiently extensive for preliminary report. It appears that there is no great diversity of genera at Sourabaya. Only the following five are represented. *Thalassophina viperina* is represented by one specimen only; *Thalassophis anomalus, Lapemis hardwickii, Hydrophis fasciatus atriceps* and *Hydrophis brookii* may be caught in any desired quantity; *Enhydrina schistosa* and *Hydrophis cyanocinctus* are not found in large numbers, and only one or two are caught at a time. Some other species of *Hydrophis* are represented in our collection by three or four specimens only; like the *Thalassophina viperina*, they are disregarded in the present investigation.

The sex ratio varies in the different forms, as is shown in Table I.

TABLE I

SEX RATIOS IN JAVA SEA SNAKE COLLECTIONS

	♀	♂	Total	Ratio
Thalassophis anomalus	250	139	389	2:1
Lapemis hardwickii	165	161	326	1:1
Enhydrina schistosa	40	33	73	4:3
Hydrophis fasciatus	42	46	88	1:1
Hydrophis brookii	31	37	68	1:1
Hydrophis cyanocinctus	22	18	40	1:1
Totals	550	434	984	

For data on breeding habits mature specimens must be distinguished from juveniles. It is quite easy to ascertain maturity when the specimen is a female carrying well developed eggs, but in others it is not easily determined. In a long series the length of the shortest specimen with large eggs can be considered to indicate the threshold of sexual maturity. Even when one has only a few animals, Galton's curve for the length from snout to vent can be used. Arranging the animals in order of length, the line connecting the ends is a lying S.

In the larger series of females the transition from the first ascent to the middle part of the curve coincides with the length of the shortest female carrying large eggs. We assume that this point in the curve is an indication of the minimum length of sexually mature animals, even in relatively small series, when actual data are not available.

If the curve for male specimens shows the same angulation as that in

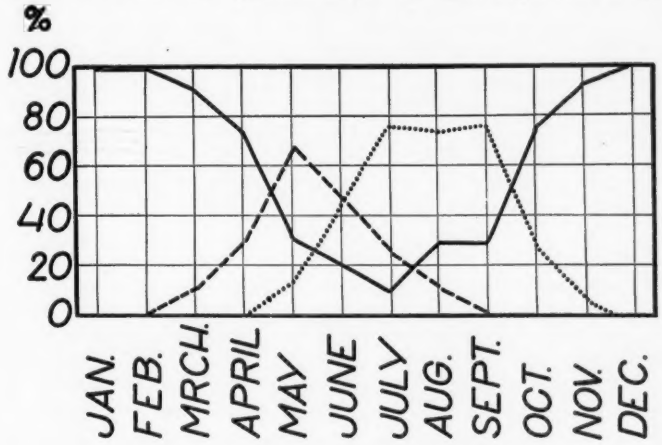

Fig. 1. Ovulation and Pregnancy in Sea Snakes

——— % Of animals with small eggs in the ovaries.
– – – % Of animals with big eggs in the ovaries.
..... % Of pregnant animals.

females, this point may be used for separating immature from mature animals. If the curves for the sexes diverge, they usually begin to do so on the bend between the first ascending part of the curve and the horizontal section.

It may be that in males the onset of maturity is really earlier than is indicated by this estimate, but if it is, our selection of adult animals will only be more rigorous than is strictly required. That sexual maturity in males should only be attained at an age shown on the horizontal portion of the curve seems very improbable. Table II exhibits the numbers of adult animals in our collection.

TABLE II

NUMBERS OF MATURE INDIVIDUALS IN COLLECTIONS

	♀	♂	♀	♂	Total
	Length at beginning of maturity		Numbers		
Thalassophis anomalus	425	425	215	107	322
Lapemis hardwickii	440	440	144	146	290
Enhydrina schistosa	700	700	31	19	50
Hydrophis fasciatus	650	600	31	30	61
Hydrophis brookii	650	650	25	27	52
Hydrophis cyanocinctus	700	700	14	14	28

Drawing up the list of specimens caught in each month and noting the females with eggs shorter than 10 mm. in the ovaries, those with eggs longer than 10 mm. in the ovaries, and the pregnant ones with eggs in the uterine tubes, it is quite clear that the eggs grow in the ovaries until they have attained their full weight and length. Then the eggs are all at once transferred from the ovaries to the uterine tubes (de Snoo, 1939: 116). Even then the eggs are smooth and oval, and no embryo can be seen even with a magnifying glass.

These yolk-filled eggs move into the uterine tubes one after another, and at this stage they are difficult to separate. A little later on, the muscles of the uterine wall contract between the eggs, and these constrictions divide the uterine tube into a number of egg-chambers corresponding to the number of eggs.

The development of the embryos begins on one side of the yolk, usually on the side of the egg nearest to the mesometrium.

Until March, the eggs in the ovaries are shorter than 10 mm. In the following month, and until June, they grow rapidly to 25 mm. and more; at the beginning of July these large eggs are in the uterine tubes, while only very small ones remain in the ovaries. These have some cicatrices reminiscent of corpora rubra. In September the embryos are well-developed, filling half of the egg, and at the end of October nearly all the yolk has been replaced by the embryo.

By about the beginning of November most of the females have given birth to their young and show by the swollen and soft uterine wall that they have been recently pregnant. The single specimen noted as carrying large eggs in the ovaries in November is a *Thalassophis*. It had only one abortive egg, a half resorbed lump of yolk.

Only a few animals are captured from November to February, and while we shall try to fill in this gap, this deficiency should not greatly affect the

data here set forth. The growth of the eggs in the ovaries begins in March, and goes on until August. Actual pregnancy is found during the months from May to November and also extends over six months. From the beginning of growth to birth of the young seven to eight months is a minimum. Our limit of 10 mm. for separating the eggs into large and small groups is an arbitrary one, and real growth presumably begins at an earlier date. The available data indicate a single ovulation cycle each year. Converted into a graph, this single yearly cycle is clearly indicated.

The number of young animals produced is very different in different genera. *Lapemis hardwickii* has two embryos per mother, and so has *Hydrophis fasciatus*. *Thalassophis anomalus* and *Enhydrina schistosa* bear 5 embryos, *Hydrophis cyanocinctus* bears about 10, and *Hydrophis brookii* 7.

Table III presents the figures, and gives also the number of young in the right and in the left uterine tubes, the former number being usually the larger.

TABLE III

NUMBER OF EGGS IN UTERINE TUBES

Name	number of snakes	number of young	average	right tube	left tube	ratio r/l
Lapemis hardwickii	17	30	2	19	11	3:2
Thalassophis anomalus	50	266	5	165	101	3:2
Enhydrina schistosa	2	11	5	6	5	1:1
Hydrophis fasciatus	13	30	2	16	14	1:1
Hydrophis brookii	6	41	7	24	17	4:3
Hydrophis cyanocinctus	2	21	10	12	9	4:3

Specimens of *Hydrophis fasciatus* mentioned in this table belong to another collection and are not included in Table I.

Many unanswered questions remain. It might be asked how the ovulation, i.e., the transfer of the large eggs to the uterine tubes, starts in June. Is there anything in the growth of egg that initiates ovulation? Could the tension rising with the growth of the content of yolk cause the eggs to break out of their ovaries? Or does the production of so much yolk disturb the hormonal balance in the ovaries, ie., is there a spontaneous ovulation? Might there be a so-called traumatic ovulation provoked by copulation? Or could climatic factors have a preponderant influence even in these tropical seas, with their uniformity of environment? It is noteworthy that the season of birth coincides with the end of the "dry" period. It is well known how disturbing the effects of these hot months can be on the biology of man (van der Schaar, 1940). Data that throw light on the matter are not yet available. It may be possible to examine the problem of traumatic ovulation by taking the male specimens into account. This will be the subject of another study.

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A List of the Fishes of McHenry County, Illinois [1]

BY ROBERT L. HAAS

DURING the summer of 1941 I engaged in a study of the fishes of McHenry County, Illinois, with Crystal Lake as a base. Collecting was confined to streams and rivers, and some species might be added to the lists below by further collecting in the numerous ponds and lakes of the county.

McHenry County is interesting, from a fish distribution standpoint, due to the fact that the eastern half is drained by the Fox River and its tributaries and the western half by the tributaries of the Rock River. These two systems appear to be well separated, in the north, by the West Chicago moraine. However, in the south, they are separated by a lower ridge, the Minooka moraine, and here, during a time of extreme floods, it is possible that the two systems are united.

This county is located in the northeastern part of Illinois and forms a part of the boundary between Wisconsin and Illinois. The county measures approximately 23.75 miles north and south, 26 miles east and west, and covers 619.5 square miles. It has an average altitude of 800 to 900 feet, the maximum being 1024 feet at Woodstock and minimum about 750 feet throughout the course of the Fox River.

The topography varies from a hilly and rolling country in the north and east sectors, to a flat or gently rolling lacustrine plain in the south and west sectors. The surface is covered extensively with clays and loams in the north and east, and with sands and gravels in the south and west. Most of the streams have cut down to form a bottomland with alluvial soil, through which they meander until they find their base levels or empty into some swifter flowing straighter coursed river.

1 My thanks are due to Mr. A. C. Weed, and to Mr. Loren P. Woods of the Field Museum of Natural History, for their assistance in identifying the collections. I am also indebted to Dr. Carl L. Hubbs for advice as to the preparation of this paper.

As Forbes and Richardson (1908: xxi, xlv) point out, the Fox and Rock rivers differ in various characteristics. The Fox River in the vicinity of McHenry County has a muddy or sandy bottom and almost all streams entering this river are extremely turbid and sluggish. In late years the Fox River has become so polluted, with refuse from manufactories along the river, "that nearly all fish except carp and other filth-enduring species," have disappeared. In contrast to the Fox is the Rock River system whose waters are bright, clear, swiftly flowing, and well oxygenated. Its stream bed is sandy, gravelly and often rocky.

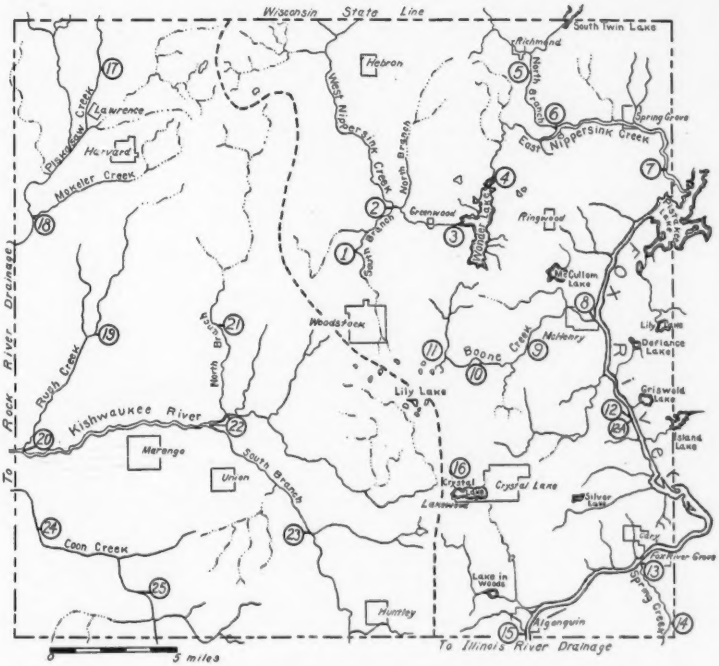

Fig. 1. Drainage Systems in McHenry County, Illinois.

These habitat differences, rather than any differences of origin of the fish faunae of the two systems, are sufficient to account for the considerable divergence shown in the lists of their fishes.

A total of 25 collections were made in 13 days from June 15 to September 1, 1941. Except for a few scattered field trips, the bulk of the collecting was done between August 11 and August 25, 1941. The localities of the collections are indicated on the accompanying map. The total number of fishes collected amounts to 6,270, representing 56 species and subspecies. The entire collection is in the Field Museum of Natural History. Lists of these fishes follow,

showing their general distribution in McHenry County with reference to the Fox and Rock River systems.

The species *Lepisosteus osseus oxyurus, Moxostoma aureolum, Perca flavescens, Percina caprodes caprodes, Percina caprodes semifasciata, Percina caprodes: caprodes* x *semifasciata* and *Eucalia inconstans,* not collected by myself in McHenry County, are represented in the Field Museum collections and are included in the lists below.

The species found in the Fox River drainage and not in the Rock River drainage, in McHenry County, are:

Lepisosteus osseus oxyurus Rafinesque.—2 specimens, FMNH 6379.

Salvelinus fontinalis fontinalis (Mitchill).—170 specimens. This species probably had been stocked in the two localities where it was found. Locality numbers: 10, 16.

Moxostoma aureolum (LeSueur).—7 specimens, FMNH 6373, 6385.

Notropis heterodon (Cope).—1 specimen.

Ameiurus melas melas (Rafinesque).—8 specimens.

Umbra limi (Kirtland).—5 specimens.

Esox lucius Linnaeus.—1 specimen.

Perca flavescens (Mitchill).—8 specimens, FMNH 6387.

Percina caprodes caprodes[2] (Rafinesque).—5 specimens, FMNH 6393.

Percina caprodes semifasciata[2] (De Kay).—108 specimens, FMNH 6008, 41106.

Percina caprodes: caprodes x *semifasciata*[2].—66 specimens, FMNH 41107, 41108.

Huro salmoides (Lacépède).—60 specimens.

Chaenobryttus coronarius (Bartram).—1 specimen.

Lepomis gibbosus (Linnaeus).—35 specimens.

Lepomis macrochirus macrochirus Rafinesque.—1052 specimens.

Lepomis humilis (Girard).—9 specimens.

Ambloplites rupestris rupestris (Rafinesque).—1 specimen.

Pomoxis annularis Rafinesque.—73 specimens.

Pomoxis nigro-maculatus (LeSueur).—57 specimens.

Labidesthes sicculus sicculus (Cope).—68 specimens.

Cottus bairdii bairdii Girard.—109 specimens. This peculiar little fish was taken in two localities within the county, both situated on Boone Creek. The water in this stream was the coldest of any creek in the county. The temperature ranged from 59° to 69° F. despite the fact that the air temperature was about 90° F. The average width and depth of the creek is approximately 10 feet and 3 feet respectively, the bottom varies from a gravelly to a muddy bed. Locality numbers: 9, 10.

Eucalia inconstans (Kirtland).—3 specimens, FMNH 11045.

Forbes and Richardson add the following species to the Fox River list:

Amia calva Linnaeus
Notropis atherinoides atherinoides Rafinesque
Notropis anogenus Forbes
Noturus flavus Rafinesque
Fundulus dispar dispar (Agassiz)
Perca flavescens (Mitchill)
Hadropterus maculatus (Girard)
Poecilichthys zonalis zonalis Cope
Poecilichthys exilis (Girard)
Lepomis megalotis peltastes (Cope)

The species found in the Rock River drainage and not in the Fox River drainage, in McHenry County, are:

Carpiodes cyprinus (LeSueur).—6 specimens. Locality numbers 18, 22, 23.

Moxostoma anisurum (Rafinesque).—1 specimen.

Cyprinus carpio (Linnaeus).—1 specimen.

Chrosomus erythrogaster (Rafinesque).—17 specimens.

Notropis rubellus (Agassiz).—59 specimens.

Notropis umbratilus cyanocephalus (Copeland).—22 specimens.

Notropis xaenocephalus richardsoni Hubbs and Greene.—49 specimens.

Ameiurus nebulosus nebulosus (LeSueur).—12 specimens.

[2] These specimens were collected in 1907–08 and have poor locality data.

Noturus flavus Rafinesque.—3 specimens.
Hadropterus maculatus (Girard).—5 specimens.
Poecilichthys zonalis zonalis Cope.—3 specimens.
Poecilichthys spectabilis spectabilis Agassiz.—2 specimens.
Catonotus flabellaris lineolatus Agassiz.—17 specimens.
Microperca microperca microperca (Jordan and Gilbert).—4 specimens. This small fish is rather rare in Illinois and was found in these localities: 17, 24, 25.

Forbes and Richardson add the following species to the Rock River list:

Ameiurus melas melas (Rafinesque)
Umbra limi (Kirtland)
Huro salmoides (Lacépède)
Lepomis gibbosus (Linnaeus)
Lepomis macrochirus macrochirus Rafinesque
Labidesthes sicculus sicculus (Cope)

The species generally distributed through the county and present in both river systems are:

Catostomus commersonnii commersonnii (Lacépède).—129 specimens.
Hypentelium nigricans (LeSueur).—20 specimens.
Moxostoma duquesnii duquesnii (LeSueur).—5 specimens.
Semotilus atromaculatus atromaculatus (Mitchill).—486 specimens.
Nocomis biguttatus (Kirtland).—47 specimens.
Rhinichthys atratulus meleagris (Agassiz).—24 specimens.
Notemigonus crysoleucas auratus (Rafinesque).—12 specimens.
Notropis cornutus chrysocephalus (Rafinesque).—59 specimens, locality numbers: 2, 3, 5, 6, 17, 18, 19, 20, 22.
Notropis cornutus frontalis (Agassiz).—197 specimens, locality numbers: 1, 2, 3, 4, 5, 9, 10, 14, 18, 19, 20, 22, 23, 24, 25.
Notropis cornutus: chrysocephalus x *frontalis*.—27 specimens. The fact that these two subspecies intergrade through this region has been observed by C. Willard Greene in "The Distribution of Wisconsin Fishes" (p. 111). Locality numbers: 14, 18, 19, 20, 21, 22.
Notropis spilopterus (Cope).—441 specimens.
Notropis deliciosus stramineus (Cope).—708 specimens.
Notropis volucellus volucellus (Cope).—36 specimens.
Notropis heterolepis heterolepis (Eigenmann and Eigenmann).—9 specimens.
Phenacobius mirabilis (Girard).—19 specimens.
Hybognathus hankinsoni Hubbs.—26 specimens.
Hyborhynchus notatus (Rafinesque).—503 specimens.
Campostoma anomalum pullum (Agassiz).—575 specimens.
Ameiurus natalis natalis (LeSueur).—5 specimens.
Schilbeodes gyrinus (Mitchill).—4 specimens.
Esox vermiculatus LeSueur.—7 specimens.
Fundulus notatus notatus (Rafinesque).—288 specimens.
Boleosoma nigrum eulepis Hubbs and Greene.—19 specimens, locality numbers: 5, 6, 14, 24, 25.
Boleosoma nigrum nigrum (Rafinesque).—26 specimens, locality numbers: 5, 19, 21, 22, 23, 24.
Boleosoma nigrum: *eulepis* x *nigrum*.—25 specimens, locality numbers: 5, 6, 10, 20, 21.
Poecilichthys caeruleus caeruleus (Storer).—25 specimens.
Micropterus dolomieu dolomieu Lacépède.—10 specimens.
Lepomis cyanellus Rafinesque.—74 specimens.

Forbes and Richardson add the following species to the above list:

Notropis umbratilus cyanocephalus (Copeland)
Fundulus diaphanus menona Jordan and Copeland
Microperca microperca microperca (Jordan and Gilbert)

With the addition of the species recorded by Forbes and Richardson, the above lists represent the total known fish faunas of McHenry County.

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FIELD MUSEUM OF NATURAL HISTORY, CHICAGO, ILLINOIS.

Experiments with the Spermatozoa of the Steelhead Trout, *Salmo gairdnerii gairdnerii*, and the Chinook Salmon, *Oncorhynchus tschawytscha*

By RICHARD T. SMITH and ELMER QUISTORFF

INTRODUCTION

MALES of the steelhead trout, *Salmo gairdnerii gairdnerii* Richardson, and of the chinook salmon, *Oncorhynchus tschawytscha* (Walbaum), are often relatively scarce among the mature fish of these two species handled in the Lewis River Hatchery System of the Washington State Department of Fisheries. The resultant deficiency of milt has often complicated the artificial propagation of these fish, and so the following experiments were undertaken to develop methods permitting the economical importation of milt obtained in distant areas where male steelhead trout and male chinook salmon are abundant. Mature fish returning in 1939 were used in the experiments which were carried out at the Cougar Creek Sub-station of the Lewis River Hatchery System.

Technique

The spawning methods in both experiments followed, in general, those described by Smith (1919) for the steelhead trout. Fertilization difficulties from broken eggs mentioned by Carl (1941) were avoided by this method by which the ova are expelled from the females with a gentle pressure. Milt from five males was collected in a dry, clean, fingerbowl, and, after mixing, was poured at once into dry, clean, homeopathic vials which were completely filled and then tightly closed. Temperature during the storage period was controlled by placing the vials in a sealed jar which was immediately immersed in the water in which the fish supplying the experimental milt and ova were kept. This procedure kept the stored milt at temperatures equivalent to those of the fish, which, according to available instruments, were not different from those of the surrounding water. The latter observation agrees with those of Clausen (1934), who found that the body of a fish tends to take the same temperature as that of the surrounding water. Temperatures in the water surrounding the storage jar varied between 6.1° and 7.0°C. for the storage period of chinook milt. Water was not allowed to contact the milt before or during the storage period, owing to the possibility of shortening the survival period of the spermatozoa from that cause. Hey (1939, 1940) found that the milt of the brown trout retained its vitality longer when handled in the absence of water, and Rutter (1904) and Reisenbichler (1879), for chinook salmon and in general spawning technique, found that the milt is active for only a short period after being mixed with water.

A small number of ova was taken from each of the five fish in each experiment, and the combined ova were used as a single lot in that experiment. Subsequent lots of ova were taken from the same fish, which were segregated in a live box during the period of spawning. In each experiment, control lots of ova were fertilized in the normal manner. The ova, after fertilization, were incubated in the Washington State Department of Fisheries standard hatching baskets under normal hatchery conditions.

Results and Discussion

The practical sources of supplemental milt for use in the artificial propagation of the steelhead trout at Lewis River Hatchery are so remote that a minimum transportation time of 2½ hours would be necessary under normal conditions. Additional milt can also be obtained in quantity where the normal transportation time approximates 5 hours. Experimental lots of steelhead ova were, therefore, fertilized with packaged milt that had been stored for 2.5 and 5.0 hours, respectively.

The various methods of handling are compared on the basis of the number of fry hatching from the ova. It was found (see Table I) that the milt of the steelhead trout loses its viability rapidly when it is removed from the fish and stored under the experimental conditions. The 4.2% mortality in the controls fertilized with milt taken directly from the live males may be taken as a standard in this test. Milt stored 2.5 hours had so lost its vitality that a 96.8% mortality resulted when it was used in fertilizing a lot of ova. The 99.7% mortality among ova fertilized

with milt stored 5.0 hours indicates that this time is very close to the limit of survival for milt handled under the experimental conditions. Scheuring (1928) found that the milt of *Salmo fario* remained active for a longer period when stored in vessels in an ice box at 4°–8°C. and suggested that the activity indicated that a good fertilization might be expected. He did not, however, check his observations with actual hatching experiments. Mortalities of the magnitude encountered in this experiment preclude the use of this technique in fish cultural establishments.

TABLE I

HATCHING MORTALITIES OF STEELHEAD TROUT OVA

Hour milt was stored	No. ova	Mortality	% Mortality
0.0	4416	187	4.2
2.5	1823	1765	96.8
5.0	4188	4175	99.7

The experiment with the chinook salmon milt was conducted with milt packaged and held exactly the same as in the steelhead experiment. A comparison was also made of the results of fertilizing comparable lots of ova with milt held in the bodies of the dead male fish. The results of these tests are given in Table II. Ova fertilized with stored milt from the vials in both experiments had a higher hatching mortality than occurred among the controls. The hatching loss of 9.5% among ova fertilized with milt stored 2.5 hours in vials is not excessively high and this method of handling might be used for transporting the milt of the chinook salmon for short distances, since portable equipment to control the temperature under which the milt is held might easily be arranged. The 45.9% mortality among ova fertilized with milt held for 5.0 hours in vials is so excessive as to preclude the use of this technique in practical fish culture.

TABLE II

HATCHING MORTALITIES AMONG CHINOOK SALMON OVA

Number Hours Milt Was Stored	In Vials			In Dead Males		
	Total No. Ova	No. Deaths	Per cent Mortality	Total No. Ova	No. Deaths	Per cent Mortality
0.0	—	—	—	1513	93	6.1
2.5	1605	152	9.5	1792	99	5.5
5.0	1637	751	45.9	1476	105	7.1

Milt from dead male chinook (see Table II) fertilized experimental lots of ova almost as effectively as that taken directly from live males. This is in marked contrast with the experience of Stroganov (1938) with the sperm of the Volga herring, which, he found, retains its vitality for about ten minutes in the dead male and is then rapidly destroyed. Milt after 5.0 hours in the dead male chinook fertilized ova with a hatching mortality of only 7.1%, an entirely satisfactory value for hatchery use. It should be noted that, under certain conditions, the bodies of male chinook might be transported under controlled temperature conditions.

SUMMARY

1. Ova of steelhead trout were fertilized with milt that had been packaged and stored in vials for 2.5 and 5 hours. A control lot was fertilized in the normal manner.

2. Holding periods of 2.5 and 5 hours were unsuccessful owing to hatching loss of 96.8 per cent and 99.7 per cent, respectively, for the two lots in contrast to 4.2 per cent among the controls with normal fertilization.

3. Chinook salmon ova were fertilized with milt that had been stored for 2.5 and 5 hours in vials and similar groups were fertilized with milt from dead males. The control lot was fertilized in the normal manner.

4. Chinook ova fertilized with milt kept in the dead males had a lower mortality than those fertilized with milt stored in vials for the same periods.

5. Chinook spermatozoa stored under the experimental condtions would be of use in practical fish culture after 5 hours in the dead males or 2.5 hours in the vials.

Conclusions

Milt of the steelhead trout cannot be successfully held under the experimental conditions owing to the very high hatching mortalities among ova fertilized with the stored milt. Milt of chinook salmon, handled as described, may be used with satisfactory hatching mortalities after 2.5 hours in vials or 5.0 hours in the bodies of the dead males.

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Washington State Department of Fisheries, 1308 Smith Tower, Seattle, Washington.

The Spawning of Chinook Salmon in the Main Columbia River

By Wilbert McLeod Chapman

DURING the month of October, 1938, the writer observed a large number of chinook salmon (*Oncorhynchus tschawytscha*) spawning in the main Columbia River below Kettle Falls, Washington. The completion of Grand Coulee Dam has flooded this area so that the phenomenon will not be seen again. Since the observations are somewhat unusual when compared with the spawning habits of this species as recorded elsewhere, the following record is made of them.

Kettle Falls were located in the Columbia River in Washington about 35 miles south of the Canadian border. Although the Falls were normally nearly flooded out during the period of the spring run-off, when the amount of water carried by the river increases tremendously, in the summer and autumn a drop in the neighborhood of 15 feet in height was presented. While the crest was broken by numerous "shoots" and shallow spots, the Falls did constitute something of a natural barrier to the upstream migration of salmon, and since long before the time of recorded history, have been the fishing grounds of that tribe now known as the Colville Indians. Immediately below the Falls the river, until the area was flooded, was compressed between high rock walls and had formed a long, deep hole. Below this hole the river widened and shallowed, until in periods of low water it was little more than 15 feet deep. In this area, which extends for several miles downstream, the bottom is entirely covered with gravel.

One of the Indian fishermen, Pete Lemery, was employed by the Washington Department of Fisheries to keep count of the number of fish caught by the Indians and make general observations. Early in October he reported fish spawning below the Falls and the writer was sent to confirm his report.

On October 19 a survey was made of the area. In the immediate vicinity five separate spawning areas were discovered. About a mile downstream from the Falls a V-shaped gravel island, with the apex pointing downstream, appears at low water. In the deep water adjacent to each arm of the V there were salmon spawning. Because of the lack of accessibility, no estimation could be made of the number of salmon on either of these spawning grounds. Mr. Lemery reported later, however, that he counted 22 redds in this stretch, although he was not able to observe the entire area.

Below this on the east side of the river two other large spawning areas were found. The upper one of these was north of the town of Kettle Falls near the old highway ferry landing. The lower one was separated from the upper by about one-fourth of a mile and extended down to the site of the former private ferry landing a little south of the town. Both of these grounds were approximately a half mile long and extended from the bank of the river

[1] The observations reported upon were made while the writer was employed by the Washington State Department of Fisheries.

as far as could be seen (about 700–800 ft.). A considerable portion of both of these beds could be seen clearly because of the height of the river bank in this section. The fifth spawning area seen was on the west side of the river a little downstream from the lower area mentioned above. Because of the depths of the water (12-15 ft.) near shore and the low elevation of the bank the extent of the spawning in this area could not be determined. Thus the spawning beds were limited to about 2 miles of the river, starting approximately 1 mile below Kettle Falls.

About half of the two spawning beds on the east side of the river were visible. In this area 350 fish were counted. This is not an accurate figure because fish were continually coming and going past the limit of visibility out in the stream. It means only that between 300 and 400 fish were seen. On the upper bed 21 redds were counted and 26 on the lower. On a spearing expedition by torchlight and rowboat later in the month, Mr. Lemery found redds farther out in the stream than could be seen by daylight, so the above figures are minimal.

The extent of the individual redds could be made out clearly because of the contrast in color between the dull gray gravel where the salmon had not worked and the white of the patches they had cleared off. They varied in size from 4 or 5 feet to as much as 25 to 30 feet in diameter. Five fish were counted working on one of the smaller redds and about 30 were counted on one of the larger ones. These redds extended from near shore, in 2 to 3 feet of water, to far out in the stream, in from 10 to 12 feet of water. From Mr. Lemery's later observations it is evident that they were present farther out in the stream and in deeper water than this. The fish seen on the spawning bed on the west side of the river were all in from 12 to 15 feet of water. It is interesting to note that there were no riffles within a mile of these three lower spawning beds. The temperature of the water on October 19 was 12.5° C.

From the various observations and the counts made of the fish on that part of the spawning grounds which could be observed closely, it is estimated that there were in the neighborhood of 800 to 1,000 chinook spawning in this 2 miles of the stream. In other words, roughly, between 15 and 20 per cent of the total chinook run in the upper Columbia (5,801 counted at Rock Island Dam in 1938) were spawning in this limited area.

It has been the writer's experience that chinook normally spawn at the heads of riffles in moderately shallow water of 1 to 4 feet in depth. And, unless they are crowded, each pair builds a separate redd. No record has been made before of salmon spawning in the main Columbia and it was assumed that the main river, at least in Washington, served only as a migratory channel and that spawning was carried on in the tributaries. But here was a large part of the upper Columbia River chinook run spawning in the main river, distant from any riffles, in water as much as 15 feet deep, out in the main current of the river, and with as many as 30 fish working on the same cleared spot.

It is generally considered that one reason salmon choose the vicinity of riffles for spawning is that the difference in waterhead forces a flow of water subterraneously through the gravel, in which the eggs are buried, in such a

manner as to ventilate and aerate the water around the growing embryos. It is possible that the deep hole below Kettle Falls, the bottom of which is lower than the bottom of the river at the spawning beds, acts in a similar manner and that there is sufficient head differential to cause underground seepage through the gravel in sufficient quantity to provide the eggs with proper ventilation. If this is so, it would partly explain the phenomenon of these salmon spawning in deep water away from riffles. If the seepage outlets were localized, it might explain the concentration of numbers of fish on the same spot when the greater part of the river bed was not in use.

Mr. Lemery first saw salmon on the spawning grounds on October 6 and in his last report on October 31 they were still spawning, although most of the fish were in a weakened condition.

The Indians reported that this was a usual occurrence and that in former years when the salmon were more abundant they used to spear them extensively on these spawning grounds. They also reported a similar spawning ground at Daisy (about 5 miles upstream from Inchelium) and at Roger's Bar (about 15 miles below Inchelium). Because of inaccessibility, it was not possible to confirm these latter reports.

Reports of chinook spawning in the vicinity of Priest Rapids (farther downstream between Vantage and White Bluffs, Washington) also came in. In a trip to this area on October 20 and 21, one spawned-out salmon was seen floating below the rapids and one chinook in good condition was seen breaking water above the rapids. The ferryman at Wahéluke, below the rapids, said that he had seen several dead or dying salmon floating downstream and that the Priest Rapids Indians gathered these "floaters" for food. It was probable that there was a spawning ground in the vicinity of the Rapids because the local inhabitants upstream from that point who were questioned reported never having seen any of these "floaters." However, no spawning fish were seen.

Ever since the counting of upstream migrant salmon was started at Rock Island Dam in 1933, the spawning places of the majority of the sockeye, or blueback, salmon (*Oncorhynchus nerka*) passing that point has been a mystery. Less than 15 per cent of the run could be accounted for on spawning grounds. In 1937, on the basis of evidence presented in "Report of Preliminary Investigations into the Possible Methods of Preserving the Columbia River salmon and Steelhead at the Grand Coulee Dam" (State of Washington, Department of Fisheries), it was concluded that the remainder spawned in the tributaries of the Canadian lakes on the upper Columbia, such as Arrow and Slocan lakes. Some confirmatory evidence was added in the summer of 1938. The Indians caught two blueback at Kettle Falls in that summer, which were examined by the writer, and reported seeing many more. On September 11, 1938, the author saw 12 blueback in Kuskanax Creek, a tributary to Upper Arrow Lake near Nakusp, British Columbia. While the fish seen were lying in a pool and not on the spawning beds, the latter were covered with redfish (landlocked form of the same species). The water temperature was 11.2° C.

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The Osteology of the Pacific Saury, *Cololabis saira*

By Wilbert McLeod Chapman

THE fishes of the family Scomberesocidae, to which the Pacific saury belongs, while related to the flying fishes, half beaks, and needle fishes, do not have the great development of the pectoral fins into "wings," on the one hand, or the excessive development of the jaws into beaks on the other. The internal anatomy of the saury is interesting because of the light it throws on the relationships of the synentognathous fishes.

It is the purpose of the present paper to report on the osteology and gross visceral anatomy of the Pacific saury, *Cololabis saira*, and discuss its relationships to other fishes. The study is based upon dissections of a specimen cast aboard the halibut schooner "Seymour" in a storm about 400 miles E ¼ S of Kodiak, August 10, 1941. For this fish the writer is indebted to Mr. H. A. Dunlop, Director of Investigations, International Fisheries Commission. Other specimens examined were: one from near Goose Island, B. C.; 4 from off the open ocean coast of Washington; one from Port Angeles, Wash., from a school washed ashore there; and one from the stomach of an albacore landed at Astoria, Oregon. The writer is indebted to Prof. Trevor Kincaid, Department of Zoology, and Mr. Arthur Welander, School of Fisheries, University of Washington, for these specimens.

Cranium

Cranium (Figs. 1, 2 and 3) long, slender, and shallow, its greatest depth 3.8 in total length, and greatest width 2.8 in length. Dorsal surface of cranium, from anterior notch of ethmoid cartilage to downward drop of supraoccipital, without depression or elevation, rounding off smoothly from mid-line to lateral edges. No temporal fossae. Ventral surface of post-orbital portion of cranium deeply pitted and compressed, leaving narrow cavity for brain.

Ethmoid cartilage (Figs. 1, 2 and 3) a solid wedge tapering from prefrontals to a thin point over vomer. Over lateral prongs of vomer it sends a cover of cartilage. Cartilage smoothly notched between nasals for reception of mesial premaxillary prongs; not pierced by any foramen, those of the olfactory nerves being entirely contained by prefrontals; ending ventrally on parasphenoid in anterior third of the orbit; continuous dorsally with cartilage of postorbital portion of cranium by means of a very thin layer of cartilage between the frontals and enlarged alisphenoids; exposed between frontals dorsally; ventral surface of cartilage under parasphenoid and posterior shaft of vomer flat.

Mesethmoid (Fig. 1) a tiny, simple, flat plate resting on top of ethmoid cartilage and between nasals.

Nasals (Figs. 1, 2 and 3) elongated, well-ossified, resting on frontals posteriorly and ethmoid cartilage anteriorly; not meeting on median line. The same bones in the related *Tylosurus* are considered by Starks (1926) to be a composite of proethmoids and nasals. No such homology is suggested by the present cranium. Although the very anterior ends of the bones over the vomer might be of endosteal origin the greater part of the

bone is no more securely attached to the ethmoid cartilage than to the frontals, and the most prominent feature of the bones are the neural canals that they carry. It would appear to the writer that the elongation of the ethmoid region of the cranium has brought about vertical stresses from the action of the mouth parts which, in the absence of ethmoid ossifications of any moment, required dorsal stiffness, and the nasals, besides their normal function of carrying the neural canals, have assumed the further function of strengthening the ethmoid region, and in so doing they have become enlarged and heavily ossified.

Frontals (Figs. 1 and 3) forming greater part of dorsal surface of cranium; everywhere separate, exposing ethmoid cartilage anteriorly and supraoccipital posteriorly; overlain anteriorly by nasals; covering most of sphenotics and supraoccipital posteriorly, and overlying anterior end of pterotics as well. Neural tube on each frontal sending off numerous tiny tubules laterally which are almost hidden in the dense ossification of the bone, but open to surface by minute pores along lateral edge of each frontal.

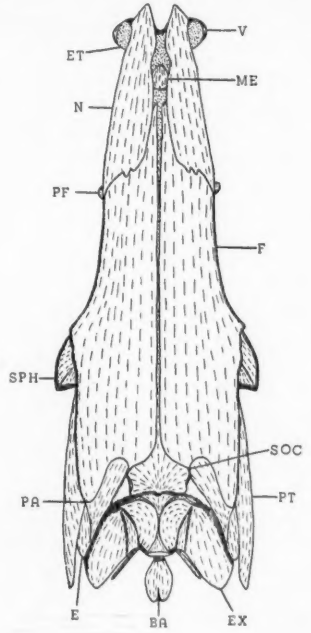
Parietals (Figs. 1 and 3) well ossified, widely separate, not quite touching supraoccipital; carrying continuation of neural canal of frontals; and lying entirely on epiotics.

Most of supraoccipital (Figs. 1 and 3) covered by frontals. Downward sloping posterior face relatively small and tapering ventrally to sharp point between exoccipitals, which bones exclude it from foramen magnum. Cartilage between bones of this region restricted to narrow bands.

The pterotics, exoccipitals and epiotics (Figs. 1, 2 and 3) are most peculiarly developed. Each bone performs its normal function of protecting the semicircular canals of the inner ear by sturdily ossified anterior portions, but posteriorly each bone sends a broad, thin, leaf-like plate. The pterotics and exoccipitals are suturally joined ventrally by strong processes. Each pterotic bears the cartilage lined socket of the posterior head of the hyomandibular. The epiotics are almost entirely covered by the parietals. Instead of the posttemporals being attached by ligaments to the epiotics they lie flat on the outer surface of the pterotics, to which they are membraneously attached. The exoccipitals barely meet dorsally over the foramen magnum, and between the diverging ends of the bones, instead of cartilage, is a tough membrane. This peculiar structure is characteristic of the synentognathus fishes and is apparently associated with the high and strong pectoral fins.

Basioccipital (Figs. 1, 2 and 3) strongly constricted laterally, and sending three long processes posteriorly under and around first vertebra. Ventral process flattened and spatulate, reaching under first two vertebrae, unquestionably strengthening an already strong structure; two lateral processes identical in shape and position to elongate parapophyses of first vertebra. Parasphenoid projecting back over ventral edge of bone, actually beyond level of foramen magnum. Basioccipital separated from prootics and exoccipitals by narrow band of cartilage, but anterodorsally a superficial vane of bone overlies edge of basioccipital, prootic and cartilage between the bones, binding these elements securely together.

Orbital and preorbital portions of parasphenoid (Figs. 2 and 3) slender, but over prootics the bone sends broad wings covering half of lateral surface of those bones. Anterior edge of each of these wings projecting up-



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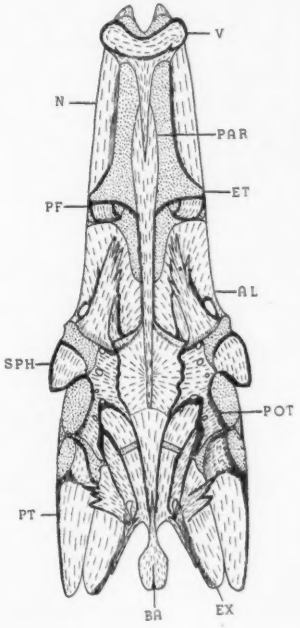

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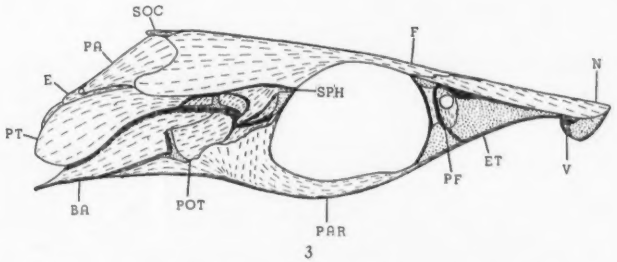

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Fig. 1. Dorsal view of the cranium of *Cololabis saira*, × 6.
Fig. 2. Ventral view of the cranium of *Cololabis saira*, × 6.
Fig. 3. Lateral view of the cranium of *Cololabis saira*, × 6.

Abbreviations: AC actinost; AL alisphenoid; AN angular; AR articular; B basibranchial; BA basioccipital; BR branchiostegal ray; CB ceratobranchial; CE ceratohyal; CL cleithrum; CO coracoid; D dentary; E epiotic; EB epibranchial; EP epihyal; ET ethmoid cartilage; EX exoccipital; F frontal; FI finlet; G glossohyal; GR gillrakers; H hyomandibular; HB hypobranchial; I interopercle; M maxillary; ME mesethmoid; MET metapterygoid; N nasal; O opercle; PA parietal; PAL palatine; PAR parasphenoid; PF prefrontal; PH pharyngeal; PM premaxillary; POP preopercle; POT prootic; PT pterotic; PTT posttemporal; Q quadrate; SC supracleithrum; SCA scapula; SOC supraoccipital; SOP subopercle; SPH sphenotic; S symplectic; SUB suprabranchial; V vomer; VH ventral hypohyal.

ward as slender splint to reach alisphenoid. Between this splint and prootic is left a long, narrow foramen through which a portion of trigemino-facial complex emerges. Bone slender again posteriorly, tapering to a point on basioccipital. Broad wings of parasphenoid forming a deep, wide, but short, myodome which extends back only about two-thirds length of prootics, and has no posterior opening.

Sphenotics (Figs. 1, 2 and 3) small but sturdily ossified bones with more than half their dorsal surfaces covered by frontals. Anterior surface concave where muscles of hyoid arch are inserted; posterior surface likewise deeply concave where levator operculus muscles attach. Anterior head of hyomandibular articulating in a deep, cartilage-lined facet between sphenotic and prootic; sphenotic somewhat curved to form one side of this cavity.

Prootics (Figs. 2 and 3) enlarged to form most of lateral surface of braincase proper. Several small nerve foramina present on both lateral and anterior faces of each bone. Prootics much strengthened and ridged posteriorly where they join suturally to exoccipitals.

Alisphenoids (Fig. 2) markedly enlarged dorsally where they form two thin plates under frontals, whose orbital surfaces they almost completely cover. Strong brace sent postero-ventrally to prootic and cartilage between alisphenoid and sphenotic. A thin sheet of cartilage lies between alisphenoids and frontals.

No orbitosphenoid or basisphenoid.

Prefrontals (Figs. 1, 2 and 3) small, thick and well ossified. Olfactory foramen entirely contained within mesial edge of bone. Bones separated from each other, from frontals and from parasphenoid by cartilage.

Vomer (Figs. 1, 2 and 3) formed of two parts: an anterior crescentic portion which is heavily ossified, bulky and concave in front; and a much thinner, dagger-like posterior shaft resting on ethmoid cartilage and lying over anterior end of parasphenoid. Vomer separated from nasals by a thin film of cartilage anteriorly.

Circumorbital Bones

Only lachrymal and postorbital left in circumorbital series, aside from an occasional tiny fragment of disconnected bone between the two which cannot necessarily be homologised with normal circumorbital bones. Lachrymal, although thin, nearly twice as long as eye and nearly as high, forming anterior border of nasal capsule, filling space between enlarged nasal and dentary, and forming strengthening structure covering long preorbital space completely between orbit and maxillary. Not channeled by suborbital branch of sensory system. Postorbital considerably smaller than lachrymal, triangular in shape with base ventral, attached to sphenotic by connective tissue, and forming support of suborbital branch of sensory system as it leaves cranium. Shallowly channeled, but with no tube formation.

Upper Jaw

No supramaxillaries (Fig. 4). Premaxillaries heavily ossified and strongly bound together mesially with mesial fork extending up between nasals to ride over indented ethmoid cartilage. Premaxillaries not pro-

tractile. Each premaxillary bears about fifteen tiny, conical teeth in a single series on its anterior half, comprising entire dorsal dentition of mouth. Maxillary also strongly ossified and bound very strongly to lateral knob formed by ethmoid cartilage and vomer; also secured to dentary by tough membranes.

Lower Jaw

Ventral edge of lower jaw (Fig. 4) strongly ossified, but rest of mandible thin and pliable. Socket of articulation borne by articular shallow and minute. Angular, while short, bulky and bound firmly by membrane to interopercle. Meckel's cartilage restricted to a thin band, mostly covered by sesamoid articular. Structure here called sesamoid articular a thin, slender spine of bone extending along mesial side of Meckel's cartilage from socket of articulation three-fourths of way to anterior end of mandible; posteriorly indistinguishably fused with articular, but separated from it for the anterior three-fourths of its length by Meckel's cartilage. Dentary broadly overlapping anterior, pliable, part of articular; most heavily ossified at symphysis; and without teeth.

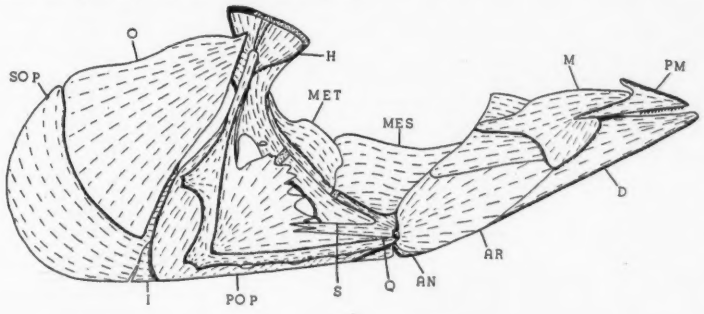

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Fig. 4. Lateral view of the suspensorium of *Cololabis saira*, × 6.

The mouth structures are most peculiarly arranged. The actual gape is small by reason of the fact that the maxillary is so tightly bound to the dentary that the mouth cannot be further opened. The gape is therefore restricted to a small opening anterior to the nasal capsule, although the articulation of the lower jaw is back under the center of the orbit.

Palatine Arch

Palatine thin, slender, simple, not bearing teeth, and so weak as to appear to have little function. No pterygoid present, but quadrate sends slender arm up to suturally attach to palatine. Quadrate (Fig. 4) consisting mainly of three slender arms, one extending antero-dorsally to palatine, a second extending postero-dorsally along symplectic to metapterygoid, and a third extending posteriorly over surface of preopercle. Articulation for lower jaw minute. Main body of quadrate little more than junction of these three arms. Small dorsal expansion of quadrate overlain by mesopterygoid.

It would seem that the usual primary function of the quadrate, that of providing a strong point of articulation for the lower jaw, has been subordinated to the function of binding the palatine, metapterygoid, symplectic and preopercle into a well-knit unit. Most of the stress of the mouth opening appears to have been taken over by the strong membraneous attachment of the maxillary to the dentary.

Mesopterygoid (Fig. 4) extremely thin, almost membraneous, but long and broad, extending from anterior end of palatine, along whose edge it runs, back to underlie metapterygoid, overlap quadrate ventrally, and fill all space between that bone and parasphenoid. It undoubtedly is of use as a support of the moderately large eye, and also serves to bind together all the elements of the palatine arch.

Portion of metapterygoid (Fig. 4) lying along hyomandibular and symplectic thickened and strongly supporting junction of those bones; dorsal wing which overlaps mesopterygoid much thinner.

Slender band of cartilage running down over mesopterygoid and along dorsal edge of palatine and quadrate. A small hump of cartilage present between quadrate and metapterygoid.

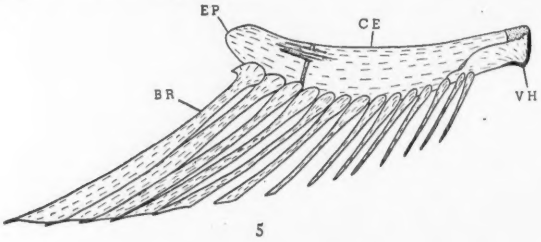


Fig. 5. Hyoid apparatus of *Cololabis saira*, × 6.

Hyoid Arch

Dorsal part of hyomandibular (Fig. 4) thick and heavily ossified. Articular head divided into two separate condyles, one articulating in cartilage-capped socket of pterotic, and other on cartilage between sphenotic and prootic well back of anterior edges of those bones. Articular head of the bone, however, not divided. No definite opercular condyle, only a long, oblong lump of cartilage on posterior edge of the bone, backed by a thickened ossification. No foramen for ramus hyomandibularis facialis, nerve emerging instead through a broad notch in ventral edge of hyomandibular. Slender ridge on lateral face of bone closely applied to entire anterior edge of dorsal arm of preopercle, binding that bone securely to hyomandibular. Ventral arm of hyomandibular less heavily ossified and separated from symplectic by narrow pad of cartilage.

Symplectic (Fig. 4) a slender rod of bone extending straight anteroventrally from hyomandibular under and between quadrate, metapterygoid and preopercle, binding all these elements tightly together.

No interhyal. Epihyal (Fig. 5) scarcely connected to hyomandibular, being strongly bound to interopercle by membranes.

Hyoid apparatus (Fig. 5) long, thin, but rather completely ossified and with components suturally as well as cartilaginously connected. Long spines of bone from epihyal and ceratohyal interlock superficially over cartilage between those two bones on both sides. Ventral hypohyal bearing broad posterior wing of bone which applies superficially on lateral side of cartilage on anterior end of ceratohyal.

Fourteen long, slender branchiostegal rays (Fig. 5) present.

Opercular Apparatus

All opercular elements present, well-developed, but thin. Dorsal edge of opercle bound to body and covered by skin so that gill opening lies entirely below uppermost ray of pectoral fin. Socket of articulation of opercle (Fig. 4) particularly large and occupies entire antero-dorsal corner of the bone. This portion of bone and short strut extending backward from it strongly ossified, but remainder thin. Crescentic subopercle joins interopercle along its entire anterior edge; tightly bound to that bone by tough membrane. Short anterodorsal horn of subopercle extends up between opercle and preopercle but fills only small part of opening between those bones. Opercle slightly overlies nearly entire dorsal edge of subopercle. These bones tightly bound together by membrane. Interopercle, except for small exposure both anteriorly and posteriorly, completely hidden from lateral view by preopercle. Interopercle thin but broadly expanded and of greater area than opercle. Dorsal arm of preopercle tapers dorsally to be no more than tube around slender neural canal. Its entire anterior edge bound tightly to a thin ridge of hyomandibular. Broad open space left between opercle and preopercle.

Gill Arches

Glossohyal (Fig. 6) sturdy, well-ossified and cartilaginous only at tip. No teeth or any trace of a dental cement bone present on glossohyal or basibranchials. Fused lower pharyngeals, diagnostic of this order of fishes, form triangular plate, flat on top and covered with small teeth that are somewhat hooked posteriorly. This plate very strongly ossified and heavy, bearing on its ventral surface a keel nearly as deep as posterior width of bone. Two sets of plates of similar teeth, borne on second and third suprabranchials (Fig. 7), appose this plate dorsally.

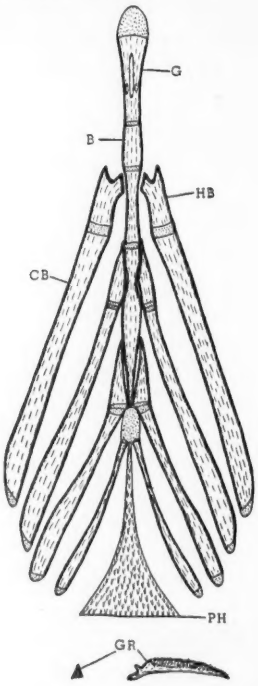
Dorsal half of gill arches short and small: lower half excessively produced forward until gill filaments extend to a vertical ahead of nasal capsule. No gill rakers on upper half of gill arch. Those on lower arch well developed and of two types (Fig. 6). Those in series on anterior side of arch long, slender, and plate-like, covered on their posterior side with densely set, tiny denticles. Longest gill raker about 6.5 mm.; thirty-six present on first arch. Those in series on posterior side of arch small, triangular rosettes of sharp denticles.

Pectoral Girdle

No mesocoracoid or postcleithra present. Posttemporal (Fig. 8) thin and oval, lying flat against broadened dorsal end of cleithrum, bearing no trace of ventral fork and only a slight projection for a dorsal fork. Tiny, cres-

centic, closed tube of lateral line system curves downward over part of external face of bone.

Supracleithrum tiny, flat, almost completely hidden by posttemporal and without much function.



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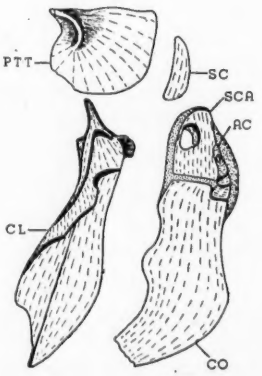

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Fig. 6. Dorsal view of the ventral half of the gill arches and posterior view of the two types of gill rakers of *Cololabis saira,* × 6.

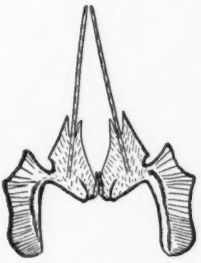
Fig. 7. Ventral view of the dorsal half of the gill arches of right side of *Cololabis saira,* × 6.

Fig. 8. Mesial view of the post temporal, cleithrum and primary shoulder girdle of *Cololabis saira,* × 6.

Cleithrum long, sturdy and rather heavy dorsally, where most of stress from highly placed pectoral fin occurs. Its dorsal face flattened and bent over at an angle of about 60 degrees to main part of bone. Two anterior and one posterior prong expand dorsal surface, to receive posttemporal. Mesial side of dorsal part of bone deeply concave. This concavity completely divided dorso-ventrally by shelf of bone which continues more than halfway down anterior edge of cleithrum. Primary shoulder girdle inserted in this cavity, the small scapula being largely enclosed in it. Entire apparatus so integrated and braced dorsally as to give a strength which seems out of proportion to needs of rather small pectoral fin. Cleithrum broadens, flattens,

and becomes thinner ventrally, although a slender rib of denser ossification bisects the bone to its anterior tip. Ventral end of the coracoid applied to this rather loosely.

Scapula small. Scapular foramen enlarged to occupy more than third of surface of bone; entirely contained by scapula and well separated from coracoid. Coracoid broad, long, and thin; lateral edge touching cleithrum dorsally, ventrally, and in the middle, leaving two small interosseous spaces; bearing no foramina and with no definite anterior or posterior processes. Four small actinosts present; two tiny dorsal-most ones borne in a notch on edge of scapula; third borne on cartilage between scapula and coracoid; and fourth, the largest, almost entirely contained in a notch on edge of coracoid. Dorsal-most fin ray borne on scapula and ventral three articulate on coracoid. Small spots of ossification, over which fin rays articulate, found in band of cartilage over actinosts.



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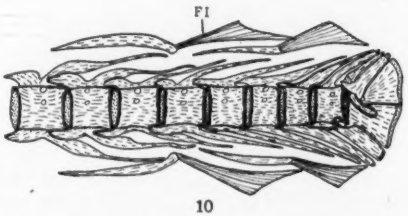

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Fig. 9. Dorsal view of the pelvic girdle of *Cololabis saira*, × 6.
Fig. 10. Hypural plate and last few vertebrae of *Cololabis saira*, showing also last two anal and dorsal finlets, × 6.

Pelvic Girdle

Pelvic girdle (Fig. 9) a dainty little apparatus not heavily ossified. Two long slender rods project forward far in advance of thin wings that each bears at either side of its base. Small surface of articulation of fin rays covered by cartilage and bone here somewhat thickened and rounded. From lateral corner of this area wings project which look as if they were made of a number of small rods welded together. These broad plates curve upward to lie just under skin and over ventral musculature, apparently serving to

distribute more broadly stresses occasioned by action of fin rays. They equal in area normal part of girdle. Such a development would hardly seem to be needed by the small fins.

Axial Skeleton

Sixty-three (39 abdominal and 24 caudal) vertebrae. None of terminal vertebrae (Fig. 10) turn upward. Entire vertebral column compactly and sturdily constructed. First three abdominal vertebrae especially adapted to accepting thrust from cranium. First has centrum heavy and strongly compacted, and spine fanning out dorsally to fill most of space between cranium and second neural spine. Parapophyses of first vertebra enlarged and projected posteriorly between similar structures on basioccipital and second vertebra, beyond second vertebra to middle of third. Second vertebra somewhat shortened, with dorsal zygopophyses broadly expanded and elevated to fill space between neural spines of first and second vertebrae. Neural spine of normal slenderness except for a distal expansion. Parapophyses similar to those of first vertebra, and even somewhat larger. Third vertebra of normal length; dorsal zygopophysis as large as that of second; neural spine longer, and slender throughout its length, with two halves securely ankylosed into a single structure, as in remaining vertebrae; parapophyses enlarged, but not as large as those of second vertebra. The structure of these first three vertebrae is singularly well adapted to withstand lateral and upward thrusts, by the system of elongated parapophyses (which work with similar structures on the basioccipital), and the broadened dorsal structures.

Beyond third vertebra parapophyses become short and stubby, bearing ribs but no intermuscular bones. Beginning with 27th abdominal vertebra parapophyses become longer and project more ventrally, until on first caudal vertebra they become ankylosed to form haemal canal and spine.

Dorsal zygopophyses, projecting from anterior edge of each vertebra, important structures thoughout, becoming gradually smaller in size posteriorly: high and more or less forked on abdominal and most caudal vertebrae. Immediately ventral to them a small spine projects posteriorly from vertebra ahead, and below it a secondary small spine projects anteriorly over edge of vertebra ahead. These three interlocking structures unite vertebrae firmly together dorsally. Beginning on first caudal vertebra similar but more slender ventral zygopophyses occur. At first they are borne on base of parapophyses, or haemal spines, but gradually creep upward until on vertebrae of caudal peduncle they merely extend forward from the antero-ventral corner of the vertebra.

Bones of caudal peduncle unusually sturdy, compact, and, in proportion to diameter of caudal peduncle, large. Bones of hypural plate forming a small but sturdy structure (Fig. 10).

No interneural spines. Finlets borne on long, slender pterygiophores not unlike those of dorsal and anal fins.

Scales

Scales cycloid, strongly imbricated, but apparently quite deciduous. Scale rows somewhat irregular and difficult to count accurately. About 129 rows from pectoral base to base of caudal, and 90 rows from occiput to dorsal

origin on one specimen. Top of head, cheeks and opercle scaly. Scales very characteristic in that circuli instead of being arranged concentrically about a focus extend directly across scale from top to bottom, being entirely straight or only a little wavy, resembling clupeoid scales. On each side of ventral midline a single series of specialized, small, perforated scales covering lateral line canal extends from isthmus to above second anal finlet.

Viscera

Digestive tract running straight from gullet to anus, and for that reason relatively short. No pyloric caeca. Small spleen closely pressed to pyloris. Intestine little smaller in diameter than stomach. Liver large and long, extending back over two-thirds of stomach. Air bladder long, simple and large, extending full length of long abdominal cavity, its walls very thin. The specimen examined was a female with slender ovaries containing undeveloped eggs that lay in the posterior third of the abdominal cavity. Short oviducts lead to a separate opening behind the anus.

Relationship

The synentognathous fishes, while without doubt a phylogenetically homogeneous group, present many difficulties both in relationships within the group and the relationships of the group to other fishes. They retain certain primitive characters, such as abdominal pelvics, lack of spines in the fins, numerous branchiostegal rays, cycloid scales, etc., yet at the same time they possess some of the most striking specializations in fish. The highly placed pectoral fins, low lateral line, specialized pharyngeal dentition, tiny mesethmoid, enlarged nasals (or combined nasals and pro-ethmoids), small supraoccipital, etc., are shared by all members of the order and show them to be a natural group (Regan, 1911; Hubbs, 1919).

Within the group two lines of anatomical specialization are apparent: that of the prolongation of one or both jaws into a beak, and the excessive development of the pectoral fins, or both pectoral and pelvic fins, to an extent that aerial planeing is possible to a remarkable extent. In *Cololabis* both of these specializations are indicated but are not developed. The mouth is short, without any development of a beak, but the nasals are strongly developed as in the genera where the dorsal beak is developed; the premaxillaries are heavy, and the dentaries are large. An interesting secondary specialization has been brought about by the strong membraneous connection between the maxillary and dentary which has reduced the gape and taken so much strain from the articulation of the lower jaw that the latter is very weak and the quadrate is much reduced in size and strength. The pectoral girdle, in the strength of the connection of the dorsal end of the primary shoulder girdle to the cleithrum, the connection of the posttemporal to the cranium, and the high placement of the fin on the body, resembles that of the genera in which the pectoral fins are developed to permit skipping or planeing. Yet the pectoral fins of *Cololabis* are small. The enlargement of the supports of the pelvic fins are out of proportion to the development of those fins. The sturdy compactness of the support of the caudal fin, with its near obliteration of the typical homocercal condition, could well reflect the strong development

and specialization of the caudal fin in other genera. Whether these various indications of the specializations of the group as found in *Cololabis* are to be taken as primitive and foreshadowing their development in other genera, or as relicts of former specializations in this line of evolution which have been again lost, cannot be stated but it would seem possible that the latter is the case.

Nichols and Breder (1928) say: "This family (the Belonidae) is certainly the most primitive of the group and although the others have come up through it, its separation as such from the main "trunk" has been early. Of the Belonidae, *Belone* with its retention of gillrakers certainly is closest to the base of the needle-fishes' line of ascent." Of the Scomberesocidae they say: "This family has clearly arisen within the Belonidae, probably at some place close to where the modern Belonids separated from the stem leading to the Macrosquamati. Differentiation within it is simple and clear, *Cololabis* being a recognizable fixed larva of *Scomberesox*."

From a consideration of the data presented by these authors it would appear that the ancestors of the Microsquamati (or Scomberesocoidea of Regan, 1911) are to be sought in fish with elongated toothed jaws, gill rakers, simple air bladder, fourth suprabranchial present and toothed, and dorsal and anal fins long, reaching nearly to the caudal as in *Belone* and *Tylosurus*. The retention of well developed gill rakers in *Cololabis* indicates that the division between the Belonidae and Scomberesocidae occurred before the development of most modern genera of the former.

The writer believes: 1. that *Cololabis*, rather than "being a recognizable fixed larva of *Scomberesox*," represents a further specialization of this line of evolution in which the dorsal and anal became shortened, with isolated rays of each separating to become finlets; 2. that this specialization is shown in the loss of the toothed beaks, the loss of teeth on the dentary, the maxillary-dentary connection becoming strong enough to take most of the strain of the mouth action away from the quadrate-articular articulation, the reduction in size of the quadrate, and the loss of teeth on the fourth suprabranchial; and 3. that this line of evolution, among known genera, terminated in *Cololabis*.

In the Hemirhamphidae of the Macrosquamati an apparently similar line of evolution leads to *Chriodorus*, which, if it had dorsal and anal finlets, would bear a strong external resemblance to *Cololabis*. The osteology of *Chriodorus* is unknown.

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Egg and Ovipositor Characters in Two Acheilognathine Fishes from Japan [1]

By Carl L. Hubbs and Katsuzo Kuronuma

Breder's outstanding paper on non-spherical fish eggs prompts the publication of this note, for which the material was prepared several years ago. According to Breder (1943), other than spherical ova occur in only two groups of teleost fishes that are not included in the Acanthopterygii. One of these is the family of anchovies (Engraulidae), the pelagic eggs of most of which—for reasons that are not obvious—are more or less elongated. The other group of soft-rayed fishes characterized by having non-spherical ova is the Acheilognathinae (we follow Chu, 1935: 3, in using this subfamily name in preference to Rhodeinae, because Acheilognathini Bleeker, 1860, has priority over Rhodeina Günther, 1868). In this group of cyprinid fishes the eggs, after passing through a greatly produced ovipositor, are laid in the mantle cavity of fresh-water mussels. The elongation of the acheilognathine ova is thus interpretable as an adaptation, correlated with a unique reproductive habit.

Although he had data on the eggs of only one of the Acheilognathinae, namely the European bitterling, *Rhodeus amarus* (Bloch), Breder presumed that other species in this essentially Asiatic group have similar reproductive habits and intimated that they too might have elongated ova. Our observations suggest that a more or less ellipsoidal egg is probably a subfamily character of the acheilognathine cyprinids.

The data for this paper were taken from four specimens of Japanese bitterlings, each of which, when preserved, had from one to five eggs in its fully extended ovipositor. Among hundreds of specimens of the subfamily secured by the senior writer in Japan in 1929 these were the only ones that were "caught in the act" of egg laying (no actual observations on oviposition were made). Sorge (1932: 150–151, fig. 7) described and figured a specimen of *Rhodeus amarus* with two eggs in its ovipositor.

Two of the specimens, identified as *Acheilognathus tabira* Jordan and Thompson, were seined by Hubbs, Pearse and Yoshimura on June 21, 1929, in Tone-gawa, a river in Chiba-ken, Japan. One came from Ichinowakeme, the other from Sasakawa. Males of this species in the same collection were in high color, and the spawning season was probably near its height. One female, 46 mm. in the standard length, has two eggs in the ovipositor: the other one, 60 mm. long, five eggs.

The two other specimens, representing *Acheilognathus cyanostigma* Jordan and Fowler, were collected by Hubbs and Miyaji, in the southern basin of Biwa-ko, the large lake of central Japan, on July 4, 1929. There is no special significance to the date, other than that it indicates when the species spawns. Males were in high color, and of the three females noted in the field as having very long ovipositors one was annotated as "running freely." One female, 44 mm. in standard length, has one egg in the ovipositor; the other, 41 mm. long, three eggs.

1 This study is one of a series supported by faculty research grants from the University of Michigan

The ova of *Acheilognathus tabira* are apparently less elongate than those of *Rhodeus amarus*, whereas those of *A. cyanostigma* are much more elongate (Table I). Those of *A. tabira* (Figs. 1–2) are nearly to quite ellipsoidal, like

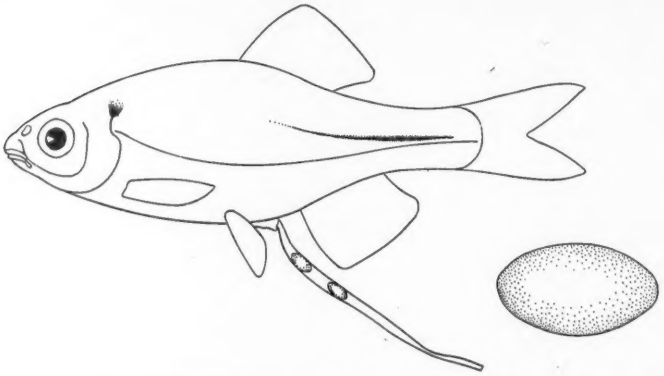

Fig. 1. *Acheilognathus tabira* Jordan and Thompson: adult female 46 mm. in standard length, with two eggs in ovipositor. Insert is an enlarged view of the more distal egg (1.26 x 2.19 mm.).

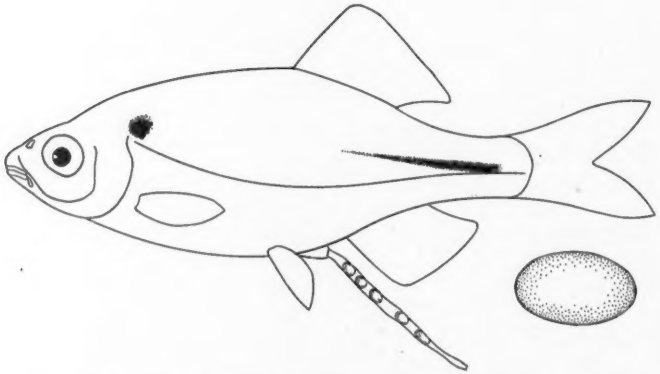

Fig. 2. *Acheilognathus tabira*: adult female 60 mm. long, with five eggs in ovipositor. Insert is of the egg in median position (1.20 x 1.99 mm.).

many fish eggs that are not spherical. Each ovum of *A. cyanostigma* (Fig. 3) approaches the form of a cylinder with rounded ends—thus somewhat resembling the eggs of certain pomacentrids (Breder, 1943: 19, fig. 6). The variation in the form of the egg in the Acheilognathinae and in the Pomacentridae is remarkably parallel.

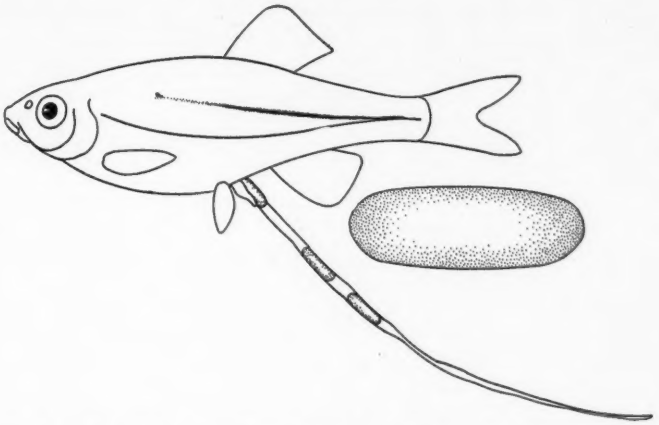

Fig. 3. *Acheilognathus cyanostigma* Jordan and Fowler: adult female 41 mm. long, with three greatly elongated eggs in ovipositor. Insert is of the most proximal egg (1.08 x 3.33 mm.).

TABLE 1

DIMENSIONS OF EGGS IN OVIPOSITORS OF ACHEILOGNATHINE FISHES

The eggs for each specimen are listed in order, from the most proximal to the most distal. The data for *Rhodeus amarus* are taken from Breder (1943: 11), and presumably are not based solely on eggs in the ovipositor.

Species	Dimensions of eggs, mm.		Ratio, $\frac{S}{L}$
	Longer diameter (L)	Shorter diameter (S)	
	2.20	1.33	0.61
	2.19	1.26	0.57
	Ave., 2.195	Ave., 1.295	Ave., 0.59
Acheilognathus tabira	1.68	1.33	0.79
	1.81	1.42	0.78
	1.99	1.20	0.60
	2.06	1.25	0.61
	2.11	1.38	0.65
	Ave., 1.93	Ave., 1.32	Ave., 0.69
Acheilognathus cyanostigma	3.33	1.08	0.32
	4.00	0.99	0.25
	4.00	1.12	0.28
	Ave., 3.78	Ave., 1.06	Ave., 0.28
	3.44	1.08	0.31
Grand averages			
A. tabira	2.01	1.31	0.66
Rhodeus amarus	2.5	1.27	0.51
A. cyanostigma	3.69	1.07	0.29

The data in Table I suggest that there may be some difference between individuals in the size of the eggs. There is some variation too in the shape of the eggs (Figs. 1–2). The measurements for the five eggs of the larger specimen of *A. tabira* may indicate that the ova increase in size as they pass through the ovipositor, but further data on this point are needed. There is reason to think, however, that the eggs change markedly in shape during oviposition.

There appear to be individual and specific differences also in the length of the fully extended ovipositor. In the specimens studied, this organ measured 54 and 33 per cent of the standard length in *A. tabira,* and 68 and 112 per cent of the standard length in *A. cyanostigma.*

The specific differences in the dimensions and form of the eggs and in the length of the ovipositor in *Acheilognathus tabira* and *A. cyanostigma* are of particular interest, since the species are regarded as very closely related (Jordan and Thompson, 1914: 217–227).

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Ichthyological Notes

A NORTHERN RECORD OF *APRODON CORTEZIANUS* GILBERT.—A zoarcid, 49.5 cm. in length, certainly belonging to the genus *Aprodon* and agreeing closely with Gilbert's description of *A. cortezianus,* was taken by otter trawl between the mouth of the Columbia River and Willapa Bay, Washington, in April, 1943. The capture was made in depths between 60 and 65 fathoms. It is interesting that all specimens reported by Gilbert came from depths well over 200 fathoms. The types of *A. cortezianus* Gilbert were taken at Albatross stations 2925 and 2948, Cortez Banks, off San Diego, California. In addition Gilbert reported a specimen from Albatross station 3349, off the coast of northern California. This capture apparently represents the first record of the appearance of *A. cortezianus* Gilbert north of California.—Vernon E. Brock, *Fish Commission of Oregon, Portland, Oregon.*

SEXUAL DIMORPHISM IN THE MINNOWS *HESPEROLEUCUS* AND *RHINICHTHYS*.—In any thorough study of geographic races it is of prime interest to ascertain which of the diagnostic characters are modified by differences in sex, and to determine the degree of this difference. This paper deals specifically with a collection of the Venus roach *Hesperoleucus venustus* from Alameda Creek, which is tributary to the west side of San Francisco Bay proper, and with a collection of the black dace *Rhinichthys osculus robustus* from Prosser Creek, Nevada County, California. Because of this the results do not apply quantitatively to all sections of the ranges of these fishes, but they are valid qualitatively. The morphological characters discussed are the permanent structural modifications due to difference in sex and so do not include the obvious seasonal differences apparent during the breeding period, such as color.

Counts of scales and fin rays, as expected, show no differences attributable to sex. The body measurements studied in *Hesperoleucus* are as follows; snout and head length, length and depth of the caudal peduncle, dorsal fin to snout, lengths of the anal, pectoral, pelvic, dorsal, and caudal fins, and the width of the pelvic girdle. The dorsal and anal fins only were studied in *Rhinichthys*. Of these, the fin lengths and the width of the pelvic girdle are measurably modified in accordance with differences in sex. All measurements were taken with calipers reading to one tenth of a millimeter and were expressed in per cent of the standard length for statistical treatment. Sex was determined by dissection and the specimens used were sexually mature adults.

The average lengths of the *Hesperoleucus* measured are 55.1 mm. for males and 59.2 for females. The average lengths of the *Rhinichthys* are 51.6 mm. for males and 59.9 for females. Thus, females are larger than males in both of these genera. This might in part account for the preponderance of females in many collections made by seining. In many samples the females outnumber the males four to one.

Summarized in tabular form below are the data for *Hesperoleucus*. Fifty specimens of each sex were measured.

HESPEROLEUCUS

	Range	Mean	S. D.	Index of Sign.
Pectoral Fin				
Female	18.4–21.6	20.01	0.80	
Male	22.0–26.4	24.26	1.07	22.8
Pelvic Fin				
Female	13.7–15.9	14.78	0.49	
Male	15.6–18.3	16.69	0.64	16.8
Pelvic Girdle				
Female	7.3– 9.5	8.28	0.53	
Male	7.9– 9.6	8.75	0.46	4.5
Dorsal Fin				
Female	19.8–23.5	21.31	0.81	
Male	20.4–24.1	22.38	0.99	6.0
Anal Fin				
Female	17.1–20.3	19.10	0.75	
Male	18.4–22.4	20.61	0.79	4.7
Caudal Fin				
Female	25.5–32.4	29.02	1.42	
Male	26.5–34.0	30.45	1.73	4.3

It is at once obvious that the male tends to be larger in these measurements than the female.

The pectoral fin is most markedly different in the two sexes. In addition to differences in length are differences in the shape of the fin, that of the female being more rounded. The pelvic fin, like the pectoral, shows marked dimorphism. The width of the pelvic girdle is subject to some sexual modification, that of the male being slightly wider. This is not surprising when one considers that the fins of the males are considerably longer. There is a considerable overlap in the ranges of the width of the pectoral girdle, but the trend is unmistakable.

Dorsal, anal, and caudal fins also show considerable overlap, but here again the average differences are unmistakable. In the caudal fin, and perhaps in the dorsal and anal fins, a sharp differentiation would be somewhat masked by slight mutilations of the fins during life.

RHINICHTHYS

This genus, like *Hesperoleucus*, shows a marked sexual differentiation in the pectoral fins. Likewise differences exist in the dorsal and anal fins, although not apparent on casual inspection. Measurements of a series of 25 males and 25 females of *Rhinichthys*

osculus robustus from Prosser Creek show indices of significance of 10.1 and 9.2 for the dorsal and anal fins, respectively. Examinations of collections of *Rhinichthys* from Cassia County, Idaho, and Harney County, Oregon, indicate that dimorphism in the dorsal and anal fins is present throughout the range of *Rhinichthys*.

Since the dimorphism of the pectoral fins is often marked, the sexes are almost always treated separately in statistical consideration of data. The sexual differentiation of the dorsal and anal fins, however, is often overlooked in racial studies. This is true, for example, in Hubbs' and Kuhne's 1937 paper on *Apocope* (= *Rhinichthys*) (Occ. Pap. Mus. Zool., Univ. Mich., 343: 1–21, 3 plates). While this lumping of the sexes would not usually lead to serious error, it is hardly consistent with precise taxonomic description. If the number of males and females were about equal in samples to be treated statistically, this practice would tend not to effect the difference in average between the samples. But, the standard error of the difference between the means for two different races would be unreliable, for combining the two sexes would spread the distribution over a wider range and tend to reduce the index of significance. In most instances this would not effect interpretation of the data, but it could easily do so in borderline cases.

One of the greatest dangers of applying statistics to biology is the tendency to lump groups of data in order to produce a larger sample and supposedly one more readily treated by statistical methods. In zoology this temptation is often accentuated by the limited samples available. This should always be avoided and every effort made to attain homogeneity of data.

Thanks are extended to Miss Margaret Storey for her kindness in allowing me to examine the *Rhinichthys* in the Stanford Natural History Museum.—GARTH MURPHY, *Department of Zoology, University of California, Berkeley, California.*

A MAJOR ANOMALY IN THE HEPATIC PORTAL SYSTEM OF *SQUALUS ACANTHIAS*.—A striking anomaly in the venous drainage of the valvular intestine was recently discovered in a specimen of *Squalus acanthias* Linnaeus in my comparative anatomy laboratory. Since I have seen this condition only once in over three hundred specimens examined, and have found no reference to it in the literature, it seems desirable to place a description of it on record. The observation is all the more noteworthy for its apparent rarity, because the typical relations between the veins of the intestine suggest that such an anomaly could arise rather frequently.

The venous drainage of the valvular intestine of *Squalus acanthias* is provided by two veins of approximately equal size, the anterior intestinal and the posterior intestinal veins. They are known also, perhaps more properly, as the ventral intestinal and dorsal intestinal veins, respectively (Daniel, J. Frank. The elasmobranch fishes. Third ed. Berkeley, 1934). The former passes forward along the right ventral surface of the intestine, receiving branches not only from the intestine but, further forward, from the ventral lobe of the pancreas, the pyloric region of the stomach, and the anterior portion of the spleen, the common vessel thus formed being designated the gastrointestinal vein (O'Donoghue, Charles H., and Abbott, Eileen B. The blood-vascular system of the spiny dogfish, *Squalus acanthias* Linn., and *Squalus sucklii* Gill. Trans. Roy. Soc. Edinburgh 55, 1928: 823–890).

The posterior intestinal vein begins in the rectal gland and follows the left dorsal surface of the intestine forward to about the place where the intestine receives the anterior mesenteric (O'Donoghue and Abbott) or posterior intestinal artery (Daniel) from the dorsal aorta. It then turns abruptly away from the intestine toward the spleen, where it receives a posterior lienogastric vein before proceding to the hepatic portal vein, as the lienomesenteric vein, through the dorsal lobe of the pancreas. The anterior and posterior intestinal veins receive a series of annular branches, these branches corresponding in position to the lines of attachment of the folds of the spiral valve. Numerous anastomoses occur between the annular branches of these two veins, so that several moderately large channels from one to the other are continuous. This condition seems to provide the basis for the anomaly here described.

As illustrated in the accompanying figure, in the anomalous specimen the drainage of both anterior and posterior intestinal veins took place through a single large vein, morphologically the gastrointestinal. The posterior intestinal vein proceded forward to about the third annular vessel, or about two annuli beyond the place at which it would

normally leave the intestine, and thence proceded diagonally forward across the ventral side of the intestine to the anterior intestinal vein. The channel leading from one vein to the other exists in the typical condition in part as a small longitudinal vessel which carries blood posteriorly into the posterior intestinal vein and in part in anastomoses between the two principal veins of the intestine. The gastrointestinal vein of the anomalous specimen was, naturally, much larger than usual inasmuch as it carried the entire venous drainage of the valvular intestine. The posterior lienogastric vein drained the posterior part of the spleen, the adjacent portion of the stomach, and flowed forward through the dorsal lobe of the pancreas, but there was no trace of any vein joining it from the intestine. It was consequently a much smaller vessel than the typical lienomesenteric vein.

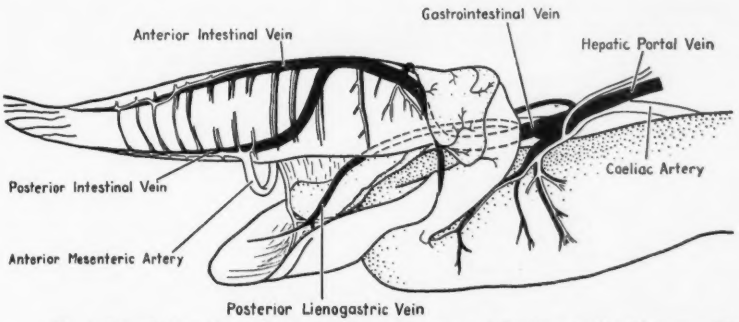


Fig. 1. Ventral view of anomaly in hepatic portal system of *Squalus acanthias* Linnaeus. The posterior intestinal vein empties into the anteror intestinal instead of joining the posterior lienogastric vein. Half natural size.

It seems apparent, of course, that the anastomoses between the posterior and anterior intestinal veins provide in part a potential path for the anomalous route. Judging from the rarity of the anomaly, however, pressure relations during development are apparently such that the channel leading across to the spleen from the intestine hypertrophies and becomes the permanent channel in practically all cases. Some resistance to passage of blood in that direction during the process of development may have brought about blood flow through one of the anastomosing channels between the posterior and anterior intestinal veins, the blood moving from the former to the latter. The relations in the adult suggest that this may be the developmental basis for the anomaly here described. They also suggest that an anomaly might occasionally arise in which the posterior portion of the anterior intestinal vein might drain through the posterior intestinal vein and the lienomesenteric, leaving only its anterior portion following the typical channel. This condition I have neither seen nor found mentioned in the literature, but it seems just as likely to appear as the one here described.—GORDON ALEXANDER, *University of Colorado, Boulder, Colorado.*

NOTE ON THE TEXAS OCCURRENCE OF A SHARK NOT PREVIOUSLY KNOWN FROM THE WATERS OF THE UNITED STATES.—In a small collection of sharks, taken at Galveston, Texas, and forwarded to Mr. Stewart Springer, of Islamorada, Florida, a female, 362 mm. in length, proved to be a specimen of *Carcharhinus cerdale* (Gilbert), a species hitherto reported only from Mexico to Ecuador on the Pacific coast (Beebe and Tee Van, 1941, Zoologica, 26(15): 109), and from the Atlantic side of the Isthmus of Panama (Meek and Hildebrand, 1923, Marine Fishes of Panama, 1: 47). The specimen, whose identification was confirmed by Dr. Wm. C. Schroeder, is now in the collection of the Museum of Comparative Zoology at Harvard University. So far as I can determine, this constitutes the first record of this shark from the waters of the United States.—J. L. BAUGHMAN, *311 Peden Ave., Houston, Texas.*

NOTES ON THE PYLORIC CAECA OF CHINOOK SALMON.—Counts of pyloric caeca are used in the taxonomy and racial analysis of the Pacific salmon, but very little information is available on counts from individual rivers. The following notes are presented as a contribution to the knowledge of the number of pyloric caeca in the chinook salmon of the Sacramento River.

In June, 1941, counts were made of the pyloric caeca removed from 221 chinook salmon (*Oncorhynchus tschawytscha*), from the Sacramento River at Redding, California. The counts have been compared with similar counts made by McGregor (1923, California Div. of Fish and Game, 9(4): 138–151) and G. H. Clark[1] and the differences analyzed statistically.

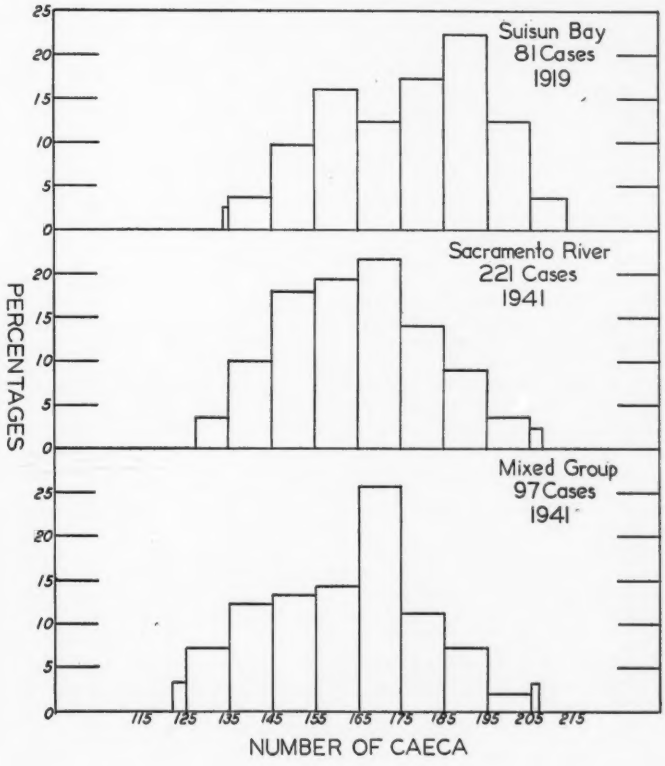
PYLORIC CAECA IN SALMON

No. of Caeca	Klamath River 1919	Sacramento River 1919	Sacramento River 1941	Mixed Group 1941
91–95	1			
96–100				
101–105	1			
106–110	3			
111–115	2			
116–120	6			1
121–125	9			2
126–130	10		1	3
131–135	9	2	6	4
136–140	3	2	11	5
141–145	8	1	11	7
146–150	6	6	12	5
151–155	5	2	28	9
156–160		4	14	10
161–165	1	9	29	3
166–170		4	21	11
171–175		6	27	14
176–180		9	17	5
181–185		5	14	6
186–190	1	6	11	3
191–195	1	12	9	4
196–200		6	5	2
201–205		4	3	
206–210		2	2	3
211–215		1		
Totals	66	81	221	97
Means	133.36	176.37	165.7	162.72

The range of the number of pyloric caeca in the 221 specimens is from 128 to 207 per fish with a mean value of 165.70 and a mode of 173. Approximately 82 per cent of the cases are contained between 135 and 195. This range is slightly wider than that of 140 to 185 given by Jordan and Evermann (1896, Bull. of the U. S. National Museum, 47: 474–483), and very much wider than that of Schultz (1938, Key to Fishes of Washington and Oregon, U. of Washington Press: 123, 51 figs.), who gives a range of 140 to 150. McGregor found a range of from 134 to 214 caeca per fish in a series of 81 specimens obtained from chinook salmon at Martinez, California, on Suisun Bay, just below the mouth of the Sacramento River in 1919. Although the range of McGregor's counts almost completely overlaps that of the writer's (see Fig. 1), when analyzed statistically the difference in means is significant ($P=<.01$). Inasmuch as McGregor's series of specimens was obtained from salmon captured below the junction of the Sacramento and San Joaquin River Systems, it is possible that the presence of

[1] Unpublished data secured by Mr. G. H. Clark, formerly of the California Division of Fish and Game, in 1941, and used in this paper with his permission.

more than one race of chinook salmon in his samples might have caused the significant difference between the means of his series and the 1941 series from Redding. To test this, 97 counts of pyloric caeca, taken from 39 chinook salmon from the Tuolumne and Mokelumne rivers of the San Joaquin System and 58 chinook salmon from the Feather River of the Sacramento System were compiled to give a series ("mixed group" in table below) as nearly equivalent as possible to the composition of McGregor's 1919 series. The range of this series was from 122 to 208 caeca per fish with a mean of 162.72 and a mode of 175. When this series was compared with the writer's Sacramento River collection the difference was found to be not significant (P=>.20), but when compared to McGregor's series the difference in means was found to be significant (P=<.01).



It is evident from the statistical analyses of these three series that considerable confusion might result from attempts to separate samples of commercially caught chinook salmon into races by means of pyloric caeca counts.

Furthermore, it is clear that any study of differences between "races," or between annual runs, requires systematic, carefully planned sampling over a succession of years. —Lewis P. Parker, *U. S. Fish and Wildlife Service, Natural History Museum, Stanford University, California.*

Herpetological Notes

WINTER HABITS OF THE DUSKY SALAMANDER, IN CENTRAL NEW YORK.—The winter habits of the eastern salamanders are not well known. During the past few years I have made certain observations on various field trips in the Ithaca, New York region, on the winter behavior of the common salamanders. One of the most abundant forms, the dusky salamander, *Desmognathus f. fuscus* Rafinesque, is easily secured in numbers throughout the year, even during the coldest periods of winter, providing one knows where to search for them.

In winter these salamanders congregate in some numbers, usually in shaly banks bordering streams, in spring runs in pastures, or on the south slope of open hills where water seeps through. Even during zero weather a few may be taken in such habitats. The salamanders appear to be governed in certain movements by temperature. In spring runs where there is a trickle of water during the coldest days, the salamanders may be found among the rocks of running streams, seeking the lower levels several inches below the rocks. Here they remain inactive until mild spells approach. When the temperature rises to 40° F. or higher, the salamanders move upward, seeking the flat stones partially exposed above the water level. In shaly banks these salamanders move from their retreats (a foot or more from the surface) when temperatures rise, working toward the surface. During mild days of January and February, with temperatures of 40–50° F., the salamanders are found just beneath the surface layer of rubble, occasionally in groups of 6 or 8.

There is no apparent segregation of sexes. The males and females usually occur together in nearly equal numbers. Of three hundred winter specimens taken from the habitats described, 54.6 per cent were males.

These salamanders apparently feed to a limited extent throughout the winter, though feeding is much reduced during the coldest spells, particularly in the areas where water is not present. Forty-one per cent of 300 specimens contained food. The food items include a variety of small forms, such as midge larvae, aquatic beetles, sowbugs, tipulid larvae, larval *Desmognathus*, mollusks, and other small forms. Mollusks are apparently retained longer than other food. That these salamanders ocasionally feed during the severest weather is proved by finding partially ingested food organisms protruding from their mouth.

Many dead salamanders are found in these winter quarters. It is not unusual to recover dead specimens totaling 10 or 15 per cent of a lot taken during the day's collecting. These dead specimens exhibit no external marks of injury and as the dead individuals are in the larger size limits, it seems probable that they have died of natural causes. During the late winter, large ovarian eggs are found in all mature females. In 131 females containing large ovarian eggs, these averaged 20.1 in number. This approaches the average nest number.—W. J. Hamilton, Jr., *Cornell University, Ithaca, New York.*

THE LIZARD NAMES *PLATYURUS* AND *COSYMBOTUS*.—The lizard name *Cosymbotus* Fitzinger, 1843 (type *Stellio platyurus* Schneider), long in use for an Indo-Malayan gecko, has recently been replaced on grounds of priority by Malcolm Smith (1935, Fauna British India, Rept., 2: 102). Smith uses instead the name *Platyurus* Oken 1836 (type *Gecko marginatus* Cuvier). Stejneger (1907, Herp. Japan: 178) refused to use *Platyurus*, apparently because he considered it to be preoccupied by the snake name *Platurus* Latreille, 1802, but the present International Rules might possibly allow *Platyurus* to stand on the basis of different spelling.

It now appears that there can be no doubt of the preoccupation of Oken's *Platyurus* of 1836. In 1828, Ritgen (Nova Acta Acad. Leop. Carolin., 14: 262) emended *Platurus* of Latreille to *Platyurus*. Under decision of the International Commission on Zoological Nomenclature (Opinion 125) such emendations preoccupy later names of identical spelling. The lizard name *Platyurus* Oken, 1836, therefore is a homonym and the Indo-Malayan gecko concerned will be known as *Cosymbotus platyurus* (Schneider).—George S. Myers, *Stanford University, California.*

THE LUNGS AND INFLATION MECHANISM OF *SAUROMALUS OBESUS*.—The inflation mechanism of the chuckawalla is of interest because of its value to the animal in protecting it from its enemies by holding it in rock crevices. Inflation may also play a part in thermo-regulation, and may have possible significance in evolution. The following study of the mechanism and degree of inflation in this animal was made under the direction of Dr. Raymond B. Cowles.

Volume measurements were made by the water displacement method. Data obtained are only approximate, but greater accuracy would have no particular significance. The specimens used were of average size.

The inflation mechanism was determined as follows. Before inflation the mouth and one nostril were sealed with liquid cement. The animal was then teased to make it inflate, and the other nostril was sealed to prevent deflation. The animal was then killed by an injection of 3 cc. of ethanol directly into its brain, and the body cavity dissected. When the peritoneum was cut the lungs protruded from the body cavity as distended, thin-walled sacs. The trachea was sealed with a hemostat, the inflated lungs and trachea were removed, and volume measurements were taken.

In appearance the lungs are simple sacs, with a small spongy diverticulum about ½ to 1 ml. in size in each lung near the place of attachment of the bronchus. The cephalic end of the lung is composed of highly vascularized tissue 2 to 3 mm. in thickness. The tissue as seen from the inner side of the lung is formed mainly of overlapping nets of blood vessels of varying diameters. These layers are so overlapped that their holes or openings in the mesh coincide, thus producing a series of small cone shaped pits over the surface of the anterior portion of the lung. The walls of these pits are formed by the blood vessels, very little connective tissue being in evidence. From the cephalic end caudad there is a progressive decrease in tissue thickness and a thinning and deconcentration of blood vessels per unit area. At the most caudal point the lungs have the consistency of cellophane and are about as transparent except for the interlacing blood vessels.

The volume of the inflated lungs was found to be 60 ml. From other calculations, the volume of the lung at the normal inflation size in respiration was found to be 15 ml. There is, therefore, a 300 per cent increase during the super-inflation over the normal lung volume. The torso, exclusive of limbs, tail, and head, has a volume of 128 ml. when fully inflated and a volume of 81 ml. deflated to normal respiration size. This shows a volume increase of 47 ml. and a percentage increase in torso volume of 58 per cent.

When inflating, the chuckawalla appears to inhale to the normal point. The animal then makes a series of swallowing motions during which it appears to force air down the trachea with the tongue. During the swallowing, it appears that the tongue is held over the internal nares, sealing the mouth cavity. At the end of each swallow the animal presses the end of the glottis between the tongue and the roof of the mouth to prevent deflation. With the lungs thus closed it takes in another mouthful of air and repeats the process. When entirely inflated the animal probably holds the glottis with the tongue. The breath is held for a protracted period. The maximum time has not been determined.

SUMMARY.—The lungs are the organs inflated in the distension of the body in *Sauromalus obesus*. The lung is described briefly. In super-inflation there is an increase of 300 per cent in the lung volume over normal respiration volume, with a similar increase of 58 per cent in the torso volume.—G. W. SALT, *Biological Laboratories, University of California at Los Angeles, California.*

EGGS OF *HETERODON SIMUS*.—A specimen of *Heterodon simus* Linnaeus from Florida, 23 inches long, and 10 ounces in weight, was kept under observation for two months, during which time eight southern toads (*Bufo terrestris*) were eaten.

Eggs were laid from October 20 to 22, two each day. They were laid in no definite arrangement. They were moist and of a smooth texture, not adhering to each other. The six eggs were almond-shaped and yellowish brown in color (the eggs of *Heterodon contortrix* are white and elliptical). They varied in length from 2.5 to 3 cm., and in width from 1.1 to 1.4 cm.; their weight on emergence was 2.1 to 2.5 grams. They failed to hatch, and were deposited in the Florida State Museum.— WINSTON H. PRICE and LLOYD G. CARR, *University of Pennsylvania, Philadelphia, Pennsylvania.*

HATCHING OF THE EGGS OF THE SAN DIEGO ALLIGATOR LIZARD.—It may be of interest to record the finding and hatching of a clutch of 20 eggs of the San Diego alligator lizard (*Gerrhonotus multicarinatus webbii* Baird). The number of eggs in this clutch is large as Fitch (1935, Trans. Acad. Sci. St. Louis, 29: 23) records seven breeding females of *webbii* that contained from 8 to 15 (av. 12.4) eggs, and Gander (1931, COPEIA: 14) remarks that an alligator lizard taken on June 20, 1930, laid 15 eggs on July 17.

The particular clutch of eggs under consideration was found by Mr. Chas. Kelly in Mission Hills, San Diego, on June 1, 1942, about 4 to 6 inches below the ground surface in a burrow of the local gopher, *Thomomys bottae bottae*. Mr. Kelly replaced the eggs in an adjacent burrow and covered them with earth. Mr. C. B. Perkins of the San Diego Zoo, consulted by Mr. Kelly concerning the eggs, found the top layer of earth covering them to be dry and the 3 uppermost eggs considerably shriveled. The remaining 17 eggs were taken, together with the earth in which they were found, to the Zoo where they were put into an earthen crock about 3 inches deep and 7 inches wide with a glass cover. The crock was placed in the office of the reptile house where the maximum day time temperature during the summer months is about 90° F. and the minimum temperature at night about 70° F. Shortly after the earth and the eggs were placed in the crock numerous small drops of moisture accumulated on the glass cover and this moisture was present throughout the period of incubation.

Except for daily cursory examinations through the glass cover no further attention was given the crock until July 25, when the newly hatched young were discovered on top of the earth. All 17 eggs hatched; the period from the time of their discovery until July 25 was 55 days. The egg shells were papery to the touch and were easily torn.

Shortly after hatching the young were preserved and are now in the collection of Dr. L. M. Klauber. The measurements of the freshly killed specimens exhibit considerable variation, the total length ranging from 79 to 104 mm. and averaging 84.0 mm. The tip of snout to anus measurement varies from 26 to 35 mm., averaging 32.2 mm. and agreeing quite well with the measurements recorded by Fitch (*l.c.*) for the young of the year of this subspecies.

Since the young of this species differ considerably in coloration from adults the following color notes were made from a freshly killed specimen in the brood. The capitalized colors refer to Ridgway's *Color Standards*. The top of the head is Buffy Olive. The dorsal ground color constitutes a single broad median band approximately Ochraceous-Buff, which continues on the upper surface of the tail to about one-third of the distance from the tip where it becomes English Red. Between the shoulders and the rump there are 9 faint transverse bars of Mars Orange, each with a median double Black spot posteriorly. There are faint indications of an irregular dorsal stripe of Mars Orange on the anterior two-thirds of the tail. There are 8 irregular lateral blotches of Chaetura Drab with Black posterior borders, narrowly separated by the Ochraceous-Buff ground color. The venter is Pale Smoke Gray with a Black line or spot on the center of each scale giving a striped appearance to the belly. The chin and gular region are Pallid Neutral Gray flecked with Black. The ventral surface of the tail is Tilleul-Buff becoming English Red near the tip. The undersurfaces of the limbs are Pale Smoke Gray with darker irregular spotting; above, Deep Grayish Olive crossed with darker bars.—CHARLES E. SHAW, *Natural History Museum, Balboa Park, San Diego, California.*

NOTES ON *DROMICUS ANDREAE* AND ITS HIDDEN *"NEBULATUS"* PATTERN.—Eight specimens of *Dromicus andreae* (Reinhardt & Lütken) taken at the Soledad Central, Cienfuegos, Cuba, show some interesting points in pattern and secondary sexual dimorphism.

The head shields are very uniform: lower labials 9; upper 8, with 3, 4 and 5 entering orbit; one each loreal, preocular and temporal; 2 postoculars. The exceptions are confined to the females. (The writer has found a preponderance of irregularities among the females of snakes and turtles.) One female has a very small scale between postoculars and temporal; another has only 8 lower right labials and the 3rd right upper labial does not enter the orbit.

We had expected to find the marked sexual dimorphism in the number of caudals that occurred in the two species of *Dromicus* on Jamaica (Grant, The Herpetology of

Jamaica, 1940: 124,5), but such was not the case. *Dromicus* lays very large eggs in proportion to its size and it might be expected that in its reduction from 17 to 15 rows the female would carry the fourth row farther back than does the male. Both sexes, however, drop the fourth row approximately opposite the 83rd ventral. There is a slight caudal difference, the males averaging 100 (98-102) and the females 96 (95-97) pairs of subcaudals. The most pronounced dimorphism is in the preanal; four of the five males have it divided and the three females have an unmodified ventral next the divided anal. Tail length percent of body length, males 53, females 50. The ventrals average for males 148 (146-150), females 147 (146-148), the opposite of what one would expect.

The largest perfect female measures body 400 mm., tail 203; similar male, 348, 193. Barbour (Mem. Mus. Comp. Zool., 47, 1919: 196) gives the measurements of M.C.Z. 10,900 as; "Total length 501; vent to tip of tail 80 mm." Since he lists "caudals 96 pairs" this specimen could not have a broken tail. If the tail is 180 instead of "80" then the measurements would be body 321, tail 180, tail per cent of body 55 which would indicate a male, but the caudal count of 96 would indicate a female.

The distal flouncing and proximal rows of enlarged spines in the hemipenes of this species are shown in the accompanying figure.

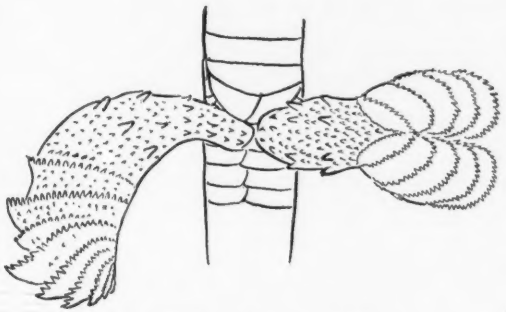


Fig. 1. Hemipenes of *Dromicus andreae*

In color, the dark parts are sometimes dark brown, but usually shiny black; chin and throat cream color, ventrals milk-white edged with black, the black edging becoming progressively wider posteriorly to such an extent that some specimens have the last third of the body nearly solid black, but the tail always retains some white. The first four scale rows are light at neck, but farther back only the first and second rows are white, tipped with black to a varying degree; a light line crosses snout, follows over eyes to parietals and beyond for several scales; frequently a black spot on first and second lower labials. Some specimens show white flecks regularly arranged along 4th, 5th, or 6th rows. If the skin is removed and stretched and viewed from the flesh side a pattern appears. The basic pattern seems to be cross bars about 3 or 4 scales long outlined by one row of white edged scales. The cross bars frequently divide at spine and alternate; again there appears to be a row of spots along each side and a row of dorsal saddles. The whole pattern is confused and is doubtless more evident in certain sections as Barbour mentions (*loc. cit.*, 1919) for Oriente and (Ann. Carn. Mus., 10, 1916) for the Isle of Pines where the difference in *visible* color pattern is marked. He says (p. 305); "In Cuban specimens there are . . . only occasional scattered white dots or vertical or horizontal series of small dots, more often no white at all in the dark dorsal and lateral zones." My findings are in accord adding only that many of the lines of small white dots run in an oblique direction and do form a confused pattern and that all but our darkest specimen show the pattern to some degree when the skin is distended.— CHAPMAN GRANT, 535 *Quince St., San Diego, California.*

NOTES ON THE WESTERN GLOSSY SNAKE IN CAPTIVITY.—There seems to be little information concerning *Arizona elegans occidentalis* Blanchard in captivity. The two snakes herein mentioned, a male and female, were received at the Reptile House, Toledo Zoological Park, May 24, 1940. When received they measured (in mm.): male, total length 900, tail 112, width at midbody 16; female, total length 771, tail 86, width at midbody 16.

Perkins (1938, Bull. Zool. Soc. San Diego: 13) mentions the preference of the glossy snake for lizards. Our specimens have continued to refuse *Sceloporus u. undulatus, Eumeces fasciatus* and *Anolis carolinensis*. Baby mice were refused when offered during the first two weeks after arrival, as were young blue racers. Two small house sparrows were put into the cage June 24 and were taken almost without hesitation. The snakes fed regularly upon young sparrows until August 19, after which time we were unable to secure nestlings. Various types of food were introduced into the cage but all were refused until October 2 when a fully adult house sparrow was released in the cage. The bird was attacked immediately by one of the snakes and was killed by constriction. The process of swallowing was exceptionally slow and laborious. Unfortunately the snake was unable to retain its meal, which was disgorged October 5.

At intervals between October 5 and February 3, 1941, adult sparrows were put into the cage but all were refused. The snakes became thin and as a last resort both specimens were force-fed on February 3. Baby mice were used for this purpose and the snakes responded satisfactorily. On March 16 we spread a small cloth sack upon the floor of the cage and placed under it two juvenile mice. The following morning the mice had been eaten. The male snake died May 16, 1941. The female, in March, 1942, appears to be in perfect condition and has continued to feed regularly and entirely upon white mice. She has grown 40 mm. in length and for the last several feedings has accepted half grown mice directly from the keeper's hand.

Mr. C. B. Perkins of the San Diego Zoological Society states in a letter that he has fed geckos (*Coleonyx variegatus*) to *Arizona elegans occidentalis*; and he recalls an instance in which *Arizona* fed on young mice. He writes further as follows: "My remarks about *Arizona* taking geckos refer to the desert form of this snake. Geckos surely are its natural food. However, on this side of the mountain, where the coastal form is found, I do not believe there are as many geckos as there are *Arizona* and certainly geckos can not be the principal food."

The female *Arizona* deposited three very elongate and cylindrical eggs July 22, 1940. The shells were white and had a leathery, flexible texture. The sizes of the eggs (in mm.) and the weight in grams were as follows: 57 x 17, weight 12.37; 60 x 17, weight 11.01; and 63 x 16, weight 11.40. An attempt to incubate the eggs was without results.—FLETCHER A. REYNOLDS, *Toledo Zoological Park, Toledo, Ohio.*

A NEW RECORD FOR BLANDING'S TURTLE IN EASTERN NEW YORK.—Two specimens of Blanding's turtle, *Emys blandingii* (Holbrook), were collected approximately three-quarters of a mile southeast of Freedom Plains, Dutchess County, New York. On August 6, 1941, a female was taken in a camp swimming pool, an excavation in the bed of a permanently flowing tributary of Sprout Creek. Another female was collected August 16, 1941, on a dirt road at a point 1500 feet away. A small lake lies between the two points of collection. Both specimens were taken after periods of wet weather. A search of the lake and its shores revealed no other specimens of *Emys blandingii* although conditions appeared favorable. Other turtles, such as *Chelydra serpentina, Chrysemys picta, Sternotherus odoratus, Clemmys insculpta,* and *Terrapene carolina,* were common in and near the lake.

Both specimens were mature. Their measurements (in mm.) are as follows: American Museum of Natural History 63767—length of carapace 191, width of carapace 124, length of plastron 175, width of plastron 102, height of shell 67; A.M.N.H. 64045—length of carapace 202, width of carapace 128, length of plastron 194, width of plastron 108, height of shell 68.

When collected, the turtles were in excellent condition and showed no signs of previous handling by man. The occurrence of more than one specimen in this locality would seem to indicate that these turtles were not introduced by man. This new locality supports the steppe theory of Schmidt (Ecology, 19: 396–407) in that these specimens

were collected a short distance southeast of the hypothetical "Steppe Corridor," which follows the Mohawk Valley. These records shorten the distance between the isolated records of New England and other colonies to the west. The only other record for eastern New York is a doubtful one for Long Island (Pope, Turtles of the United States and Canada, 1939).—MAX HECHT, *178 Amboy Street, Brooklyn, New York.*

ADDITIONAL NOTE ON THE RANGE OF *BUFO CANORUS* CAMP.—Stanton (1940, COPEIA, 1940: 136) reported two specimens of the Yosemite toad taken some 38 miles southeast of Tioga Lake, the easternmost known station for the species. Since that time three more sets of specimens of this species have been added to the collections of amphibians in the Natural History Museum of Stanford University. Two of the lots consist of two specimens only, while the third is an excellent series of 45 individuals. They were taken at the following places: Bond Pass, near head of Jack Main Canyon, just outside Yosemite National Park, alt. 10,000 feet, Earl S. Herald, July, 1937, two females measuring 51 mm. and 74 mm. long, respectively; Lake Mildred, Mono County, alt. 10,000 feet, Kenneth Stanton and Douglas Motley, June 23, 1940, a series of 45 specimens, 23 males and 22 females, ranging from 37 mm. to 60 mm. in length; and a meadow between Lunch Meadow and Emigrant Lake, R21E., T5N., U. S. G. S. topographic map, Dardanelle Quadrangle, alt. 9,300 feet, Ira L. Wiggins, August 11, 1942, one male measuring 51 mm. in length, and one female 59 mm. long. These last specimens bear catalogue numbers 7750 and 7751, respectively, in the Natural History Museum amphibian collections. The female had not deposited her eggs but was crawling toward one of the small pools in the meadow when she was taken; the eggs were ready for spawning.

The last named lot and the one collected by Mr. Herald at Bond Pass extend the range of the Yosemite toad nearly 35 miles northwesterly from the Tioga Lake locality, the northernmost point at which this toad was previously known to occur. Both of these localities are in Tuolumne County, and within about 4 miles of each other. The altitude here given for the locality above Lunch Meadow is based upon a reading of an aneroid altimeter set at a bench mark at Relief Reservoir only a few hours earlier. It is about 200 feet lower than the altitude shown for that point on the topographic map.—IRA L. WIGGINS, *Natural History Museum, Stanford University, California.*

CLEMMYS MUHLENBERGII IN MARYLAND.—Cope, in a "Sketch of the zoology of Maryland" (Walling and Gray's new topographical atlas of Maryland. Philadelphia. O. W. Gray, 1873: 16-18) states that *Clemmys muhlenbergii* Schoepff is "confined to the northeastern portion of the State." He cites no locality and probably based this remark upon records from southeastern Pennsylvania. Brady (1937, Proc. Biol. Soc. Wash., 50: 137-140) notes that this species has been "reported between canal and river in vicinity of [Plummer's Island]." His record of its occurrence at Stubblefield Falls, Virginia, (1924, COPEIA: 92) lends credence to this report. A specimen has now turned up which definitely establishes a locality for this species in Maryland. This turtle was collected by Joseph Bures and Conrad Kenney on August 8, 1941, in Baltimore County, along Poplar Run, near where it is crossed by the Grave Run Road, about 1 mile north of Grave Run Mills and about 2 miles west and slightly south of Rockdale. This is rich farming country and the surrounding area is hilly or rolling in character, very sparsely wooded, and without prominent rock formations.

The turtle was found imbedded in hard yellowish to yellowish-brown clay beneath a board. The board was 15 or 20 feet from the stream which at this time of year had narrowed down to a foot or so in width leaving the surrounding banks muddy and soggy. The specimen lay right side up in a torpid condition with its head and limbs withdrawn. When removed, the carapace and entire body were found to be caked with mud and the turtle appeared lifeless. Several hours later it became active and then emitted an odorless liquid presumably from the bladder.

This specimen is a large adult male which shows signs of considerable age. The carapace is 96 mm. long with nearly parallel sides, and measures 66.3 mm. in width at the posterior edge of the bridge.

This specimen has been assigned number 450 in the herpetological collection of the Natural History Society of Maryland.—ROBERT H. MCCAULEY, JR., *Plainfield, Vermont,* and ROMEO MANSUETI, *Natural History Society of Maryland, Baltimore, Maryland.*

REVIEWS AND COMMENTS

SYSTEMATICS AND THE ORIGIN OF SPECIES FROM THE VIEWPOINT OF A ZOOLOGIST. By Ernest Mayr.—Columbia University Press, New York, 1942: xiv+334 pp., 29 figs. $4.00.—Systematic Zoology and Botany, whether from the standpoint of the old systematics or of the "new," is still much in need of dignified and forceful presentation of its claim to a fair share of attention and effort from biologists. The results of a generation of neglect of systematics and of the associated morphological studies by university biologists are now extremely obvious when it is desired to have some collection of animals competently identified. It is all too likely that the only specialists available for various groups will be found to have ten years of identification work already stored on their shelves, or that no specialist at all will be available for many groups of invertebrates. University zoologists and botanists depend to a considerable extent on museums for such identifications, but there are far too few museums and far too few taxonomists in them to keep up with the demands upon this identification service. The demand on systematics is four-fold: (1) to get the life of the world adequately described; (2) to establish an evolutionary (or natural) classification of the forms discerned and named; (3) to keep systematics abreast of other biological disciplines, so that the advances of knowledge in such other fields may be applied to its material and to its procedures; and (4) to serve these other fields of biology in turn in such various directions as identification, bibliography, and suggestion of new problems or new modes of attack upon old ones.

Ernst Mayr, a practicing taxonomist in the field of ornithology, brings to America a thorough knowledge of the work of his German contemporaries, especially Rensch and Streseman. One finds in his bibliography an excellent key to the important European literature, which is inadequately known to American systematists, with their well-known inferiority complex when faced with foreign print. It is the more interesting to note that in Mayr's bibliography of 450 titles, in spite of his competent knowledge of the German literature, English and American references are more than twice as numerous as German.

The opening two chapters deal with the methods and principles of systematics (31 pp.); chapters three to seven (154 pp.) discuss geographic variation; and the final three chapters (114 pp.) deal with non-geographic speciation, the biology of speciation, and the evolution of the 'higher categories.'

The principle of geographic differentiation of the species of animals into subspecies, may almost be said to have been invented in North America. In Europe it was seized upon as a subject for theoretical speculation. It appears to the reviewer that the American school has contributed more to the field by active description and study than has the European by taking thought. The broader biological implications of the taxonomic categories have now come into focus on both sides of the Atlantic especially as result of genetic analysis by Sumner, Dice, Hubbs, and latterly by Sturtevant and Dobzhansky, and from another direction, through the intensive studies of mosquitoes and malarias arising from medical needs.

Systematics and the Origin of Species will certainly be read with profit by practicing systematic zoologists. To students of other groups than birds, Mayr's wealth of example of the various categories of specific and subspecific differentiation in the bird group will be especially valued for comparison with the corresponding phenomena in other vertebrate and invertebrate groups (of his 29 illustrative maps and figures, 22 are ornithological). His stand against undue generic splitting in ornithological taxonomy, in which he does not hesitate to name the offending splitters by name, should have a salutary influence.

The preoccupation with geographic races on the part of ornithologists leads to an over-valuation of geographic isolation in evolutionary differentiation, and a corresponding under-emphasis on isolation mechanisms other than the geographic.

The reviewer's principal criticism of the book lies in its carrying over comprehen-

sive generalizations from the taxonomic phenomena of ornithology to animals in general, and perhaps in its too positive tone as to the conclusions of ornithological taxonomy.—KARL P. SCHMIDT, *Field Museum of Natural History, Chicago, Illinois.*

GENERAL ZOOLOGY. By Tracy I. Storer. McGraw-Hill Book Co., New York, 1943: xii+798, 551 figs., 5 pls., $3.75.—A general textbook of zoology is of especial interest to the readers of COPEIA when its author is well known to them through his technical papers. Dr. Storer has attempted a comprehensive introduction to general zoology at the college level from a systematic approach.

The section on general animal biology consists of eleven chapters and occupies 254 pages. The common frog is described in some detail as an introduction to animal morphology; after the general discussion of animal structures, successive chapters deal with reproduction and development, heredity, ecology, animal distribution, evolution, the history of zoology, and classification and nomenclature. Each chapter is provided with a suggestive and useful bibliography.

A systematic review of the animal kingdom occupies the remainder of the book, devoting a chapter to each principal phylum, lumping several of the less important into a single chapter, and expanding the treatment of the Arthropoda into three chapters and of the Chordata into nine. Thus a rather well balanced view of the diversity of form and structure of animals is presented. The excellence of the work as a general introduction results from this broad systematic base, and its usefulness is greatly enchanced by comprehensive and competent illustration, mostly original.

The most general criticism applies to the overloading of the text with technical terms and to the over-use of bold-face type to emphasize them, which mars the typographic appearance of the pages. Bold facing might better be limited at least to such terms as are to appear in the glossary, and makes a disagreeable impression in such common words as lip, nose, or ear.

The author's attempt to make the systematic portion useful as a reference work is far from successful. In the chapter sections on classification, for example, lack of space reduces the mention of many groups of animals to a list of names meaningless without definition or orientation, and the bibliography fails to include references that would clarify them. Thus the extinct orders of mammals (p. 717), and the omission of Scott and Romer from the chapter bibliography. Numerous minor errors might have been avoided by further circulation of the chapter MSS among specialists. My colleague, Dr. Fritz Haas, points out that in the chapter on mollusks, the classification of the Pelecypoda is an obsolete one; that the common oyster is said to produce pearls; that scallops are said to be unattached; and that the number of misspellings of scientific names is unnecessarily large. In the chapters on fishes, the classification omits all reference to the now well known work of Stensio and his colleagues, and to the recent summary of Berg. For the Amphibia, the classification of the Salientia follows Noble, without reference to the important subsequent commentaries on family classification by H. W. Parker or D. D. Davis; the family Ascaphidae is referred to as the Liopelmidae; and the bibliography omits such works as Boulenger's *Tailless Batrachia of Europe*, which is still a model of form and of adequate illustration. In the reptile chapter the soft-shelled turtles are said to be without a bony shell, the remarkable sensory function of the Jacobson's organ is not mentioned, there is no mention of the mosasaurs or gavials, and the classification of the snakes is not in accord with most recent work. For the mammals, the reviewer remarks especially the table of origins of domestic animals, in which the domestic cat is said to be derived from the European wildcat, the ancestry of the various breeds of dogs seems to be much too positively stated, the asses and half-asses appear to be confused, and the guanaco does not appear as the common ancestor of the llama and alpaca. Such matters of details may be of little importance to an *introduction;* but they are vital to a work of reference.

In general, the reader is left with no clue to the fact that much remains to be done to establish a satisfactory classification of animals. The authoritative tone of textbooks may account for the surprise with which the general public discovers that there is no available handbook for the birds of the Solomons or of the Aleutians, or for other groups of animals in other regions. The need for competent systematic work at

every level in the taxonomic scale and in every degree of technicality might well receive greater emphasis in a work directed to the taxonomists of the future.—KARL P. SCHMIDT, *Field Museum, Chicago, Illinois.*

THE BIOTIC PROVINCES OF NORTH AMERICA. By Lee R. Dice, Univ. of Michigan Press, Ann Arbor, 1943: viii+78, 1 map, $1.75.—North American biotic studies have been in considerable chaos since it became evident that the Life Zone arrangement of Merriam is inadequate for faunal partition of the continent. Merriam and his co-workers, with their grand plans for a true 'Biological Survey,' laid a groundwork in the eighties and nineties that retains much usefulness when the limitations of their viewpoint are understood. These limitations, now pointed out by a succession of competent faunal geographers, necessitate a broader view of the origins of biotic provinces, and especially the recognition of the fact that other factors than temperature may be the controlling ones. I miss the references to these critiques in the present work.

The viewpoint is heavily weighted in the direction of ecology and of phytogeography. It was a major defect in the Life Zone hypothesis that it was non-evolutionary; the faunal and floral geographer must necessarily deal with endemism, and thus with isolation, evolution, and the historical factor generally. Ecologists are inclined to avoid, sometimes even intentionally, the complexities introduced by evolution. But in any broad view of biogeography, this complexity must be faced and analyzed: I have attempted some such analysis of the origins of faunae in my own papers on Lower California on the endemisms of the Prairie Peninsula.

A faunal partition diverges somewhat from the floristic due to different limiting factors, different modes of dispersal, and to different rates of evolution. Arrangement of the provinces in related series might be significant. Zoologists will be inclined to want a separate Floridian Province. Nearly all of the names are geographic, with other derivation only in the attractive *Artemisian* and *Palusian* for the Great Basin, and in the clumsy *Austroriparian* for the Gulf and Atlantic coastal plain.

Dr. Dice's work, while frankly experimental, will have an especially valuable influence in standardizing the nomenclature of biotic provinces however much his actual list may be altered. Alterations in his system in the direction of secondary partition or recombination rather than in fundamental respects are to be expected.—KARL P. SCHMIDT, *Field Museum of Natural History, Chicago, Illinois.*

A CHECK LIST OF NORTH AMERICAN AMPHIBIANS AND REPTILES. Fifth Edition. By Leonhard Stejneger and Thomas Barbour. Bull. Mus. Comp. Zool., 93: XIX +260. $4.00.—The appearance of the fifth edition of the *Check List* so shortly after his death commemorates Leonhard Stejneger's half-century of active interest in North American herpetology and is a monument also to more than a quarter-century of cooperation between himself and Thomas Barbour in the production of the successive editions. The first edition, in 1917, included 504 named forms, and this number has risen to 750 in the intervening twenty-six years. This increase, shown in tabular form below, is an index to the stimulus to herpetological studies provides by the Check List.

Edition	Salamanders	Frogs	Crocodiles	Lizards	Snakes	Turtles	Total
I	81	72	2	134	154	61	504
II	80	72	2	183	191	62	590
III	86	81	2	174	205	65	613
IV	102	86	2	184	234	73	681
V	130	93	2	191	260	74	750
Forms added, 1917–1943	49	21	0	57	106	13	246

As I remarked on the occasion of my review of the fourth edition of this work, it is not intended to use the present review to set forth criticisms of detail or lists of omissions and changes regarded as desirable. These should be prepared for publication, so that they may accumulate in the interest of future revised editions.

That such future editions of the *Check List* are to be desired, and are, indeed, a necessity for the further health growth of herpetological studies in North America, requires no argument. With the dissolution of the partnership Stejneger and Barbour by the death of the senior partner, it may be suggested that the function of continuing the check list of North America amphibians and reptiles might be assumed by the American Society of Ichthyologists and Herpetologists; but it is to be hoped that Dr. Barbour will continue his interest in it, and perhaps that he may be persuaded to assume the leadership of a committee of the Society for this purpose. In any case, the Society and all students of herpetology are profoundly indebted to him for his share in the production of his work and for his material support, which is actually only an index to his generous aid to herpetology in less conspicuous ways.—KARL P. SCHMIDT, *Field Museum of Natural History, Chicago, Illinois.*

COMPARATIVE VERTEBRATE ANATOMY. By Libbie Henrietta Hyman. Second Edition. University of Chicago Press, Chicago, 1942: xx+544, 136 figs., $3.50.—Miss Hyman's excellent manual has been still further improved by the opportunity for a second edition. She remarks that the financial success of her work has enabled her to live a life of singular freedom, devoted to writing and to research. How effective and fortunate that life has been is shown equally by her revision of the *Comparative Anatomy* and her distinguished recent volume on the Lower Invertebrates. The dates in her valuable chapter bibliographies document the extent of her revisions, which increase the work from the 380 pages and 68 figures of the first edition to 544 pages and 136 figures.

Comparative Vertebrate Anatomy serves to remind the reviewer of his own anatomical illiteracy. When he was an undergraduate, one of those perennial intradepartmental feuds, all too familiar in universities, kept him in the camp opposed to that in which Comparative Anatomy was given. Thirty years study of the taxonomy and natural history of amphibians and reptiles has scarcely overcome the resulting handicap. It is some comfort to have Miss Hyman's book at hand for reference.—KARL P. SCHMIDT, *Field Museum of Natural History, Chicago, Illinois.*

MARINE PRODUCTS OF COMMERCE, THEIR ACQUISITION, HANDLING, BIOLOGICAL ASPECTS AND THE SCIENCE AND TECHNOLOGY OF THEIR PREPARATION AND PRESERVATION. By Donald K. Tressler. Reinhold Publishing Corporation, New York, N.Y.: 1–702, 225 figs. $12.00.—The classic of fishery technology continues to be Tressler, published in 1923, and neither revised nor superceded since. While searching the second hand stores for a copy of this important work, recently, I was delighted to learn that it has been reprinted. Even though the book is absurdly out of date—for example, "the most important use of shark-liver oils is in the tanning industry for the currying of leather. . ." it is still the only one of its kind; and the care and authoritativeness with which it was written, make it still useful and important more than twenty years after its production. It is to be hoped the publishers will encourage a revision in the not too distant future.—L. A. WALFORD, *Stanford University, California.*

NEW BOOKS RECEIVED

NATURALIST AT LARGE. By Thomas Barbour. An Atlantic Monthly Press Book, Little, Brown and Co., Boston, 1943: 314 pp., 23 illustrations. $3.50.—"Current and choice."

LIFE THROUGH THE AGES. By Wm. Gordon Huff. Huff and Strong Series, Stanford University, 1943; 19 x 25 inches. $.50.—Admirably drawn restorations of extinct animals arranged in a phylogenetic tree are superimposed on a geological time scale. Suitable for wall decorations or for teaching use.

MY TURTLES. By Josephine Gibson Knowlton. Privately published, Washington, D. C.: 222 pp., 22 pl. (frontisp. in color), portrait of author, and colored jacket by Charles Dana Gibson. $15.00.

EDITORIAL NOTES AND NEWS

Charles Tate Regan

IN JANUARY of this year ichthyology suffered a severe loss in the death of DR. CHARLES TATE REGAN, F.R.S., formerly Director of the British Museum (Natural History).

Regan was born at Sherborne Dorset, in February, 1878, the son of a violinist and a pianist, and was educated at Derby School and Cambridge University. In 1901 he joined the staff of the British Museum (Natural History), which he served successively as Assistant Keeper, Deputy Keeper (1919), Keeper of Zoology (1921) and Director (1927–1938).

To systematic zoology Regan brought those most valuable qualities, an excellent memory, a great capacity for hard and concentrated work, and, above all, a mind capable of quickly grasping the essentials from a mass of details. He followed in the tradition of great industry established by Günther and Boulenger, who had always kept in mind that their first duty was to name, describe and catalogue the Museum collections and to have them in such order that they were available for their purpose of a great reference collection. Regan, too, never shirked the more routine duties of naming incoming collections and registering, labelling and cataloguing them. At the same time, however, he was doing more fundamental work revising families and overhauling the major classification of fishes. This work was done not only in what was left of official hours, but also at his home in the evenings. The evening meal was taken early so that he might have a long uninterrupted spell at his drawings or at writing up the results of the day's practical work.

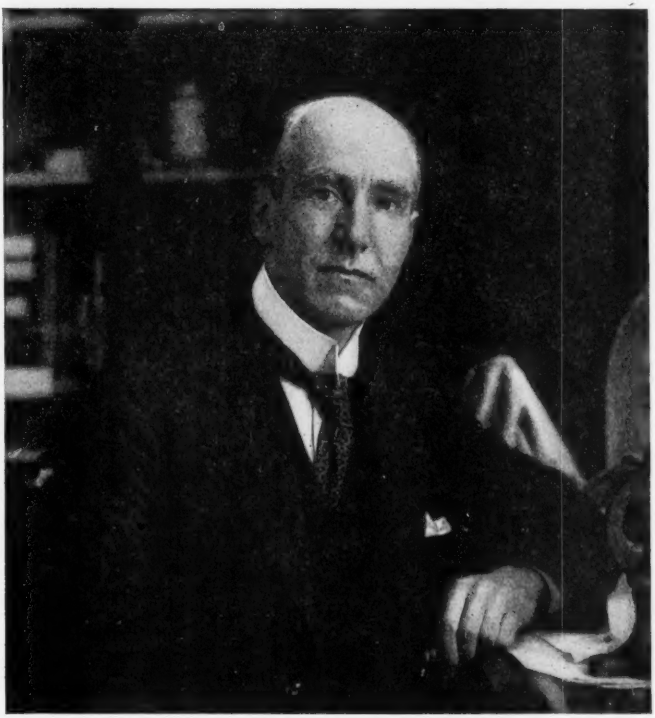
The papers on major classification began in 1908 with the Selachii, and a spate of them appeared in the years 1911–1913. In 1911 the *Annals and Magazine of Natural History* published papers in which ten Orders or Suborders were defined with diagnoses of their families, and in the same year appeared Regan's delightful popular book on the freshwater fishes of the British Isles, as well as four papers on more restricted subjects. In 1912 seven more papers on the anatomy and classification of Teleostean Orders were printed, as well as fifteen other papers, some of which involved a great deal of detailed work. Two of the twenty-one papers appearing in 1913 dealt with the Scleroparei and the Percoidea, and another was the classical revision of the Poeciliinae.

These papers are so short and concise that they give little idea of the amount of research that lay behind them, and this is only realized when one begins to tread the same ground and use the papers. In his work on classification Regan perhaps erred on the side of brevity (an uncommon fault), so that on reading the articles it is not always possible to estimate the validity of the evidence used, nor to know the number of observations on which a general statement is based. Experience shows that the data are usually fuller than, at first sight, one might guess; they were drawn from the study of a large collection of dried skeletons as well as from spirit specimens.

Regan's quick, eager temperament did not include the patience to acquire elaborate techniques. His instruments were a centimetre rule, a pair of dividers, scissors and a good hand-lens. A generation relying upon the free manipulation of a magnified object, made possible by the binocular dissecting microscope, could only look on with fascinated horror while Regan dissected some small rare fish, perhaps with the point of his dividers, guided by occasional peeps through a hand-lens. For finer work he would use the low power of a monocular compound microscope, and his detailed work on the gonopodium of the Poeciliinae was done by this means. Regan thought that his eyes were unsuited to the use of a binocular, and although the cruder instrument set limitations to his work, they were by no means so narrow as might be supposed; the accuracy of his and of Boulenger's observations with a hand-lens is astonishing.

In 1913, Regan had briefly described the first known phallostethid from specimens sent to him by Dr. George Duncker of Hamburg, and he went on to explore the morphology of the complicated copulatory organ of the males of *Phallostethus* and *Neostethus*, using serial sections and specimens cleared in clove oil. His results were

presented to the Zoological Society during the last war and were published in 1916. Soon after this he was elected Fellow of the Royal Zoological Society at the age of thirty-nine.



C. Tate Regan.

Up to 1916 Boulenger had taken on all work on African freshwater fishes (as well as his curatorship of reptiles and amphibians), but after the war, when it was possible again to concentrate on fundamental work, the difficult problems presented by the rapidly evolving Cichlidae attracted Regan's attention, and in 1920 appeared the first of his papers on the African members of the family, in which were laid the foundations of a more natural division into genera. He arranged for large collections to be made in the African lakes, and had hoped to monograph the family; the completion of that task is left for his successors.

Regan's friend, Johannes Schmidt, asked him to work out some of the "Dana" collections, and in 1925 Regan made the astonishing discovery of the dwarfed and parasitic males of some of the deep angler fishes. When, in 1927, he was appointed Director of the Museum, he found that administrative duties left him little time during official hours for scientific work. He needed an assistant who would keep the practical work going; he would supervise it and take part in it when he could and would take notes and drawings home at night. As his assistant, therefore, I came to the Museum,

in 1928. For me this was an ideal introduction to systematic ichthyology, combining contact with the vigour and enthusiasm and mature experience of a master with the opportunity of handling the unique material of the fine "Dana" collections of stomiatoids and, later, a second collection of angle fishes. Regan took special pleasure in this work, and particularly in our opportunity to relate the free-swimming dwarfed males to their extremely dissimilar mates.

Such discovery of fundamental relationships under superficial diversity he held to be one of the choicest rewards of the systematist, and he always looked back with special satisfaction to his paper of 1907 in which he demonstrated the relationship of *Lampris, Velifer,* and *Trachypterus,* uniting them for the first time in one Suborder, Allotriognathi.

Tate Regan was primarily a morphologist, whose interest lay in the bearing of structure upon relationships and evolution. "The main interest of systematic work," he wrote in 1925, "lies in the fact that it is a study of the results of evolution." He believed that there was much evidence to suggest that the first step in evoluionary change was a change in habit, but he was increasingly unwilling to dogmatize. He never believed that modern genetical work had anything to do with the problem of the origin of great groups or even of species. A geneticist to whom he was introduced on one occasion remarked, "It does make a difference, doesn't it, when one realizes that a species is simply a gene complex?" "It does" agreed Regan after a tense pause, and bade the younger man "Good morning," realizing that conversation between them was impossible.

Regan was a man of medium height and build, with a light, quick step, a keen glance, and a clear voice. He expressed himself clearly, unhesitatingly and uncompromisingly. His sense of humour was lively and he loved to tell, and to hear, a good story. In his youth he was a keen sprinter, jumper and Rugby football player, and he always enjoyed watching a good game or athletic contest. He married in 1904 and had four children; one of his two sons is now a prisoner of war in Italy.

In this notice I have covered Regan's work and his career quite inadequately, and have aimed rather at showing what kind of man he was, and what were his methods and his attitude to his work. He was engaged on fundamental research until a few weeks before his death, and in him vertebrate zoology has lost a master.—ETHELWYNN TREWAVAS, *British Museum (Natural History), London, England.*

News Notes

DR. WILBERT MCLEOD CHAPMAN, Curator of Fishes at the California Academy of Sciences, recently sailed on a South Seas fisheries assignment. His place at the Academy is being filled for the duration by DR. J. L. KASK, formerly with the International Pacific Salmon Commission.

PROF. JOHN OTTERBEIN SNYDER, one of the outstanding ichthyologists of the Jordan group, died at Palo Alto on August 19. An obituary notice is being prepared for the next number of COPEIA.

News has been received of the death of ENSIGN HAROLD WOODALL during a cruise in the Pacific area. Ensign Woodall enlisted in the Naval Air Corps after completing his Master's work at the University of California at Los Angeles. He had shown much promise as a herpetologist and will be greatly missed by his associates and his many friends.

Additions to and changes in the honor roll of Society members in the United States war services are: ADAMS, LOWELL, Army Air Corps; BAILEY, SGT. JOSEPH R., Army Air Corps; CAGLE, LT. FRED R., Army Air Corps; CRENSHAW, CADET JOHN W., Army Air Corps; DAVIS, CPL. D. DWIGHT, A.S.T.U., U. S. Army; EVENDEN, CPL. FRED G., JR., Army Air Corps; FRANKLIN, MALCOLM A., Army Medical Corps; FREY, SGT. H. E., U. S. Army; KAUFFELD, CPL. CARL F., Army Medical Corps; LACHNER, SGT. ERNEST A., Army Air Corps; NECKER, WALTER L., U. S. Army; OBRECHT, SGT. C. B., U. S. Army; OWEN, LT. ROBERT P., U. S. Army; REICHELDERFER, ENS. THOMAS, U. S. Navy; SEALANDER, PH. M. JOHN A., U. S. Navy; SELF, SGT. W. CLARK, U. S. Navy; VAN DUYN, GUY, Seabee, U. S. Navy; WAITE, JOHN R., Army Air Corps; WHITE, BRIG. GEN. THOMAS D., Army Air Corps; WOODS, ENS. LOREN P., U. S. Navy.

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